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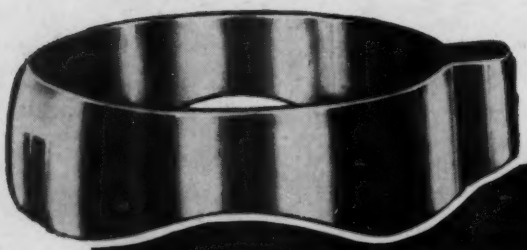

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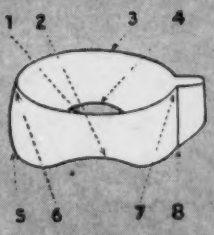

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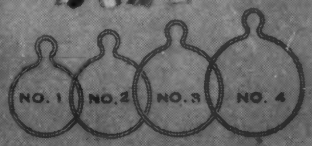

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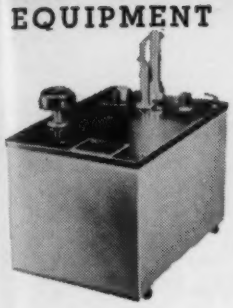

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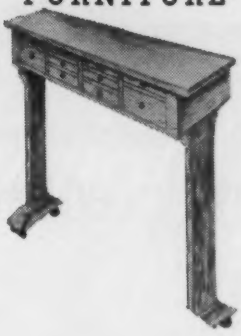

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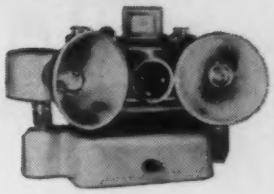

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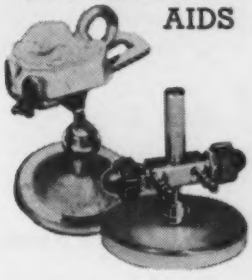

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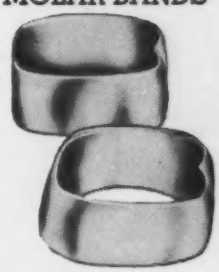

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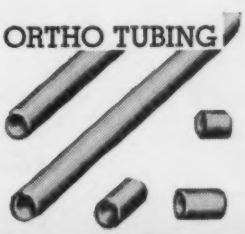

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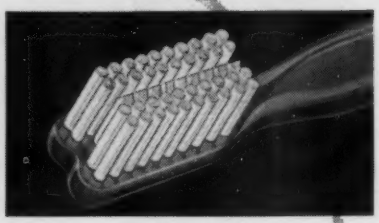

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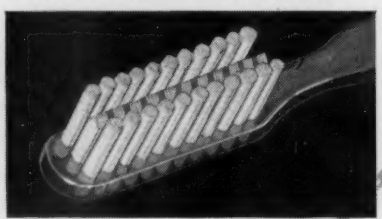

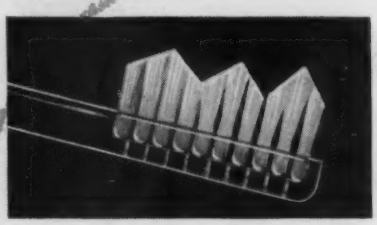

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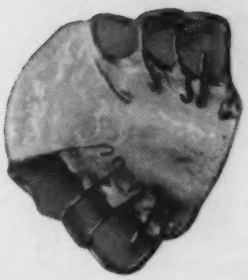

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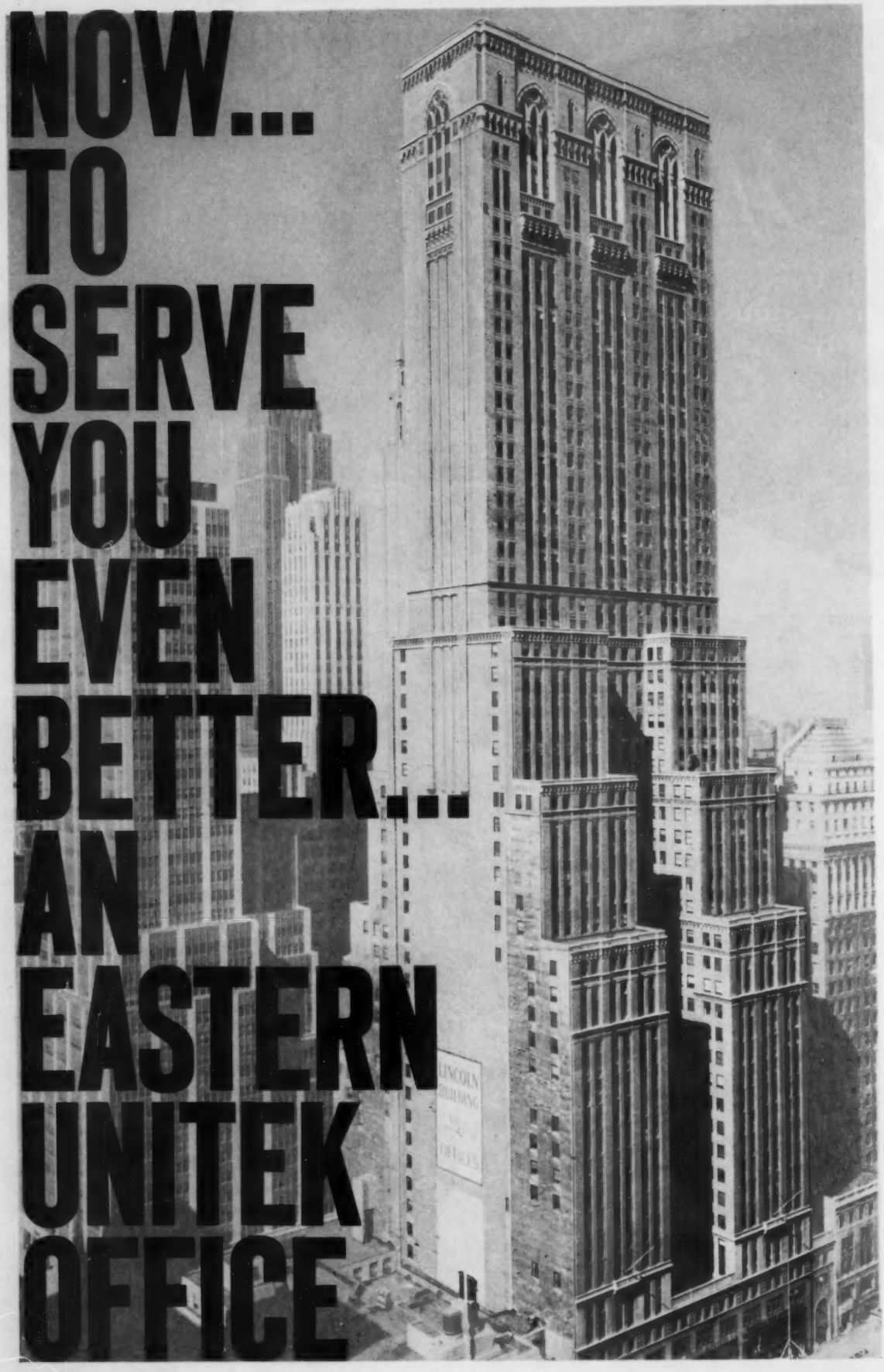

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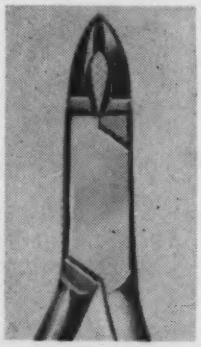

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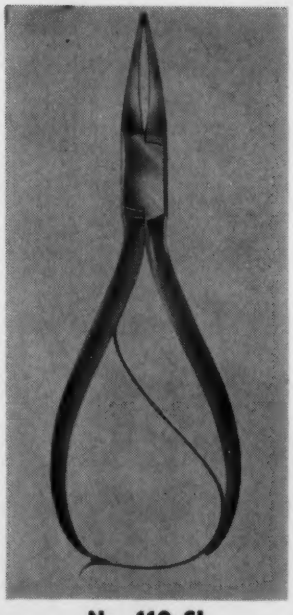

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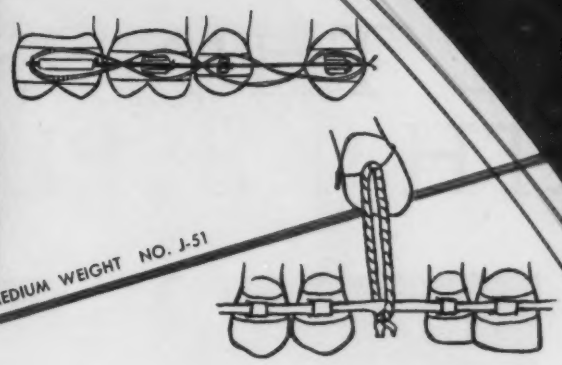

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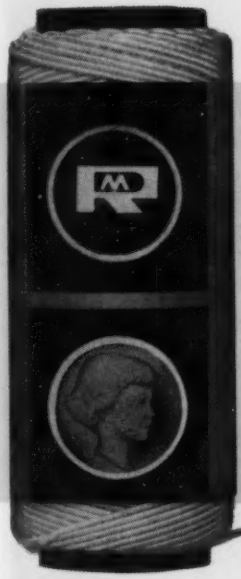

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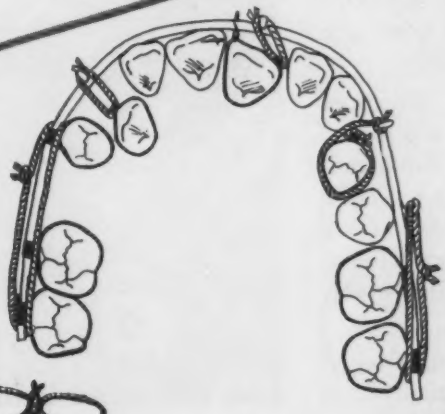

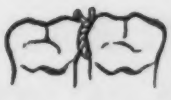

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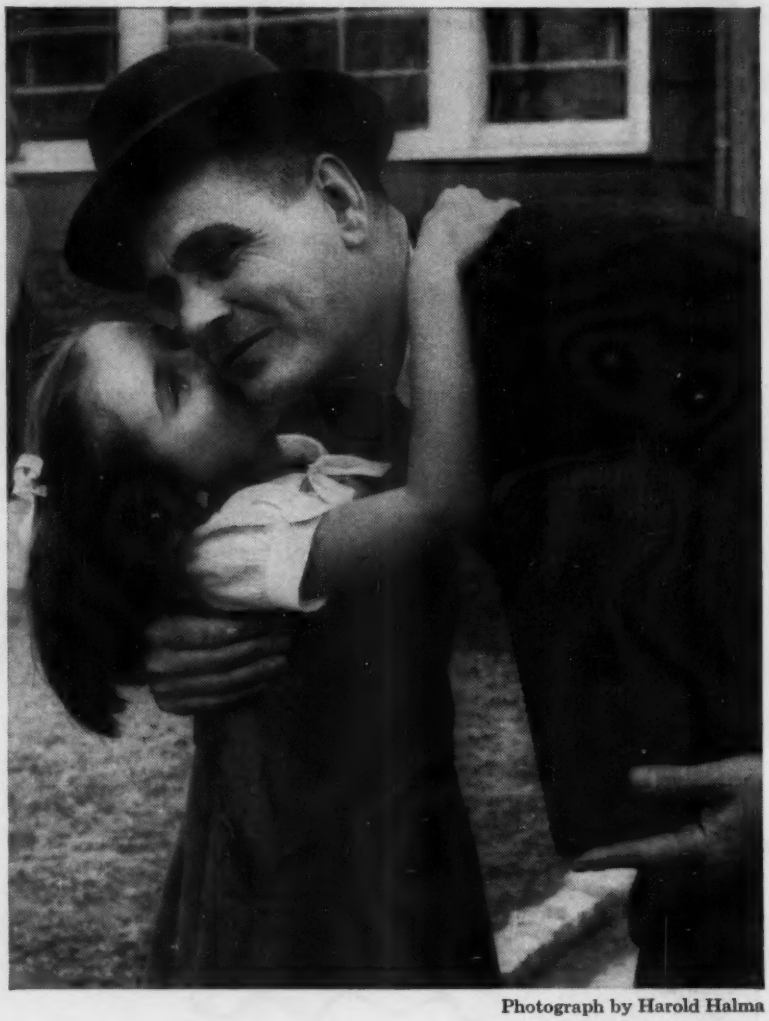

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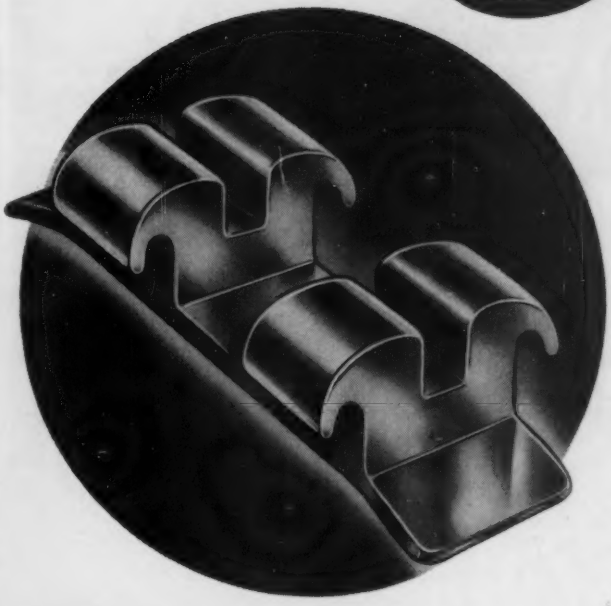

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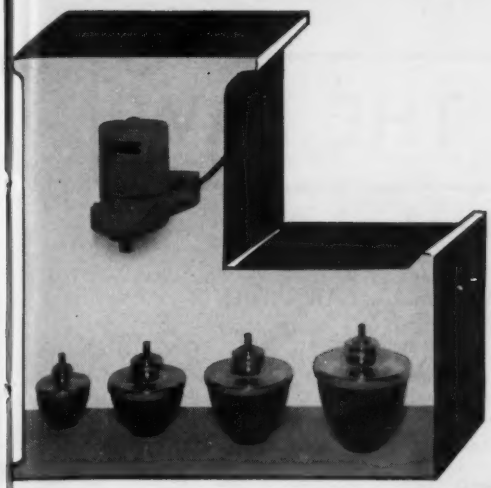

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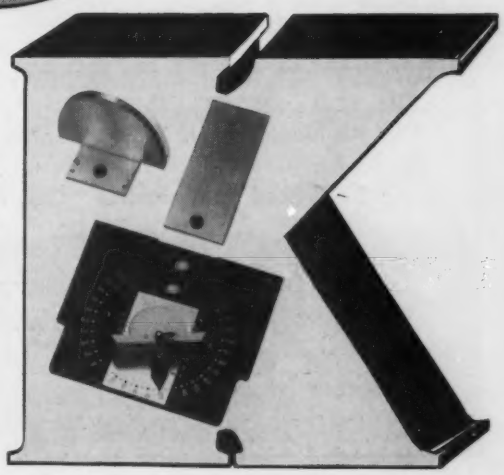

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by

CHARLES WENDELL CARNAHAN

Ph.B., J.D., LL.M., Jur. Sc.D.

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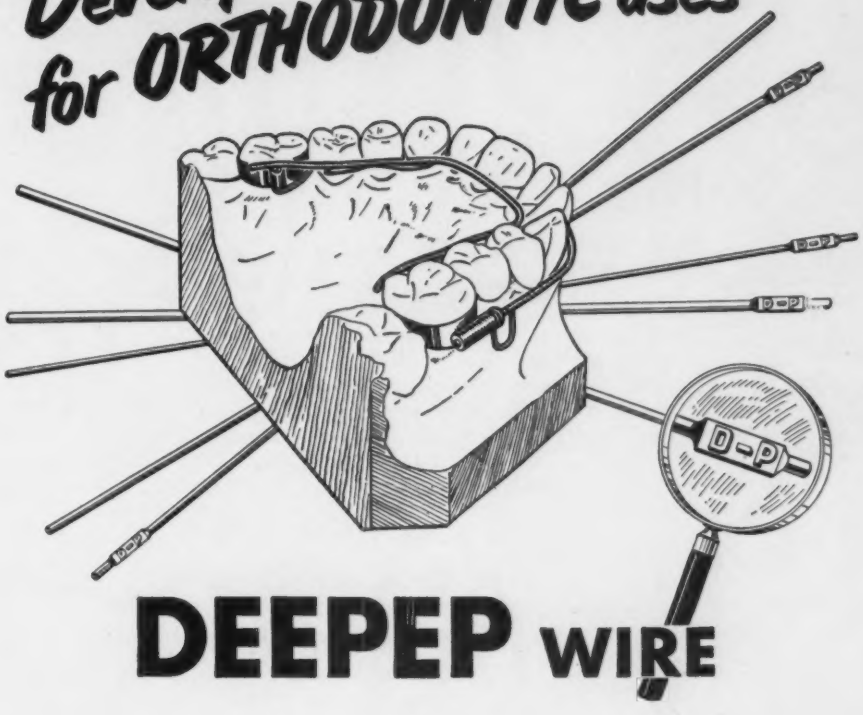

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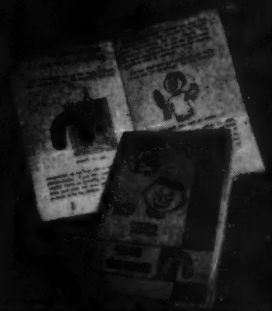

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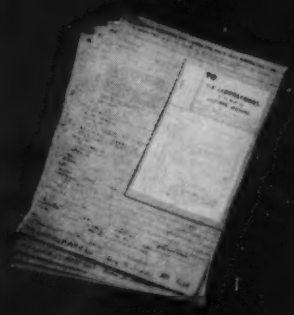

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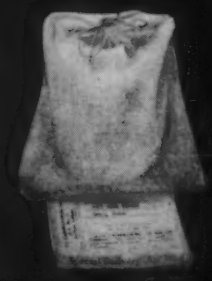

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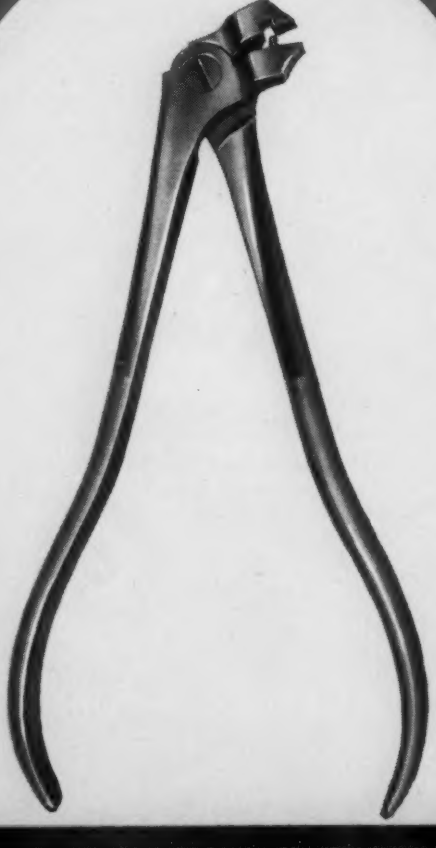

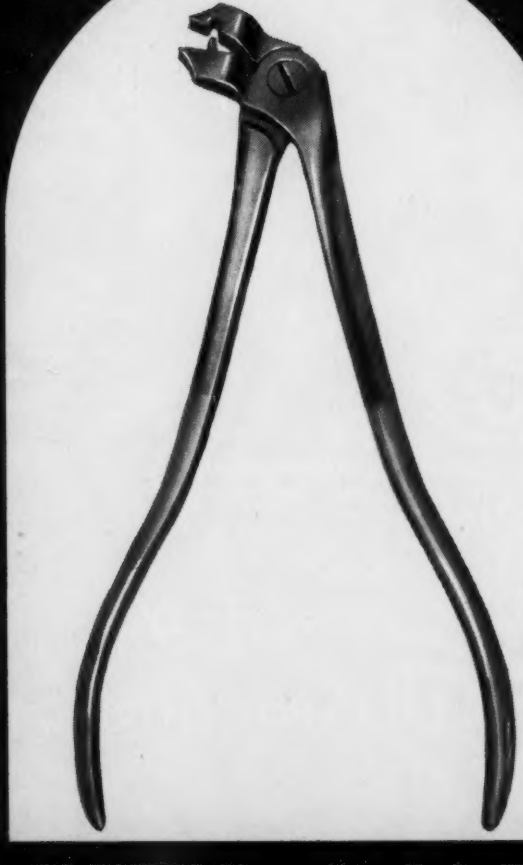

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of

ORTHODONTICS

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Original Articles

PRESIDENT'S ADDRESS, AMERICAN ASSOCIATION OF ORTHODONTISTS

FRANKLIN A. SQUIRES, D.D.S., WHITE PLAINS, N. Y.

EACH president has assumed that the purpose of a presidential address should be to acquaint the members with some of the more important matters concerning our Association and to make suggestions and recommendations directed toward the improvement of the Association's effectiveness and the general good of the specialty of orthodontics. It most certainly is not my intention to depart from this practice.

At the annual session held in May of last year perhaps the most significant action taken at the business meetings was the rescinding of the provision in the by-laws which made it mandatory for all future applicants for membership to have satisfactorily completed a course in orthodontics of a minimum of 1,500 hours in an approved dental school. In its place an amendment to Chapter I, Section 2 was adopted. This provides for two types of eligibility requirement in addition to a specified number of years in the exclusive practice of orthodontics:

(1) Satisfactory completion of a course in orthodontics of a minimum of 1,500 hours in an approved dental school.

(2) Completion of a definitely defined three years' preceptorship training.

Presented at the annual meeting of the American Association of Orthodontists, New York, New York, April 28, 1958.

In New Orleans it seemed to be the opinion of most of those who entered into the discussion on this subject of membership that the formal university-conducted training of one year or longer should eventually be required for all applicants, but as uniform standards or minimum requirements had not as yet been established by the universities or the American Dental Association, we should await such development before adopting this requirement.

At the time the new amendment was adopted the Admissions Committee, which is composed of the eight directors from the constituent societies, offered four or five resolutions and several recommendations, all of which were accepted. One of these was to the effect that each constituent society should develop a program for the guidance of the preceptor, in conformity with current orthodontic educational methods and, further, that the constituent societies should be responsible for the development of mechanisms to assure that the provisions of preceptorship training are being carried out.

The constituent societies, as requested, have followed this directive, and at this session the Admissions Committee of the American Association of Orthodontists has considered the plans suggested. I am confident that it will present a program of minimum requirements which will be acceptable to all.

We are assuming a great responsibility under our newly devised preceptorship training plan in orthodontics. I would ask you to remember that the character and future conduct of the young men with whom you work will be molded by your conduct and example even more than by your professional ability.

I wish to call the attention of the constituent societies to a resolution adopted at the New Orleans session making it mandatory that they have an associate membership classification. Previously, as you may know, each constituent body had the authority to maintain an associate membership if it so desired. The minimum requirements for such membership are outlined in the A. A. O. by-laws.

Unless it is the intention of the Association that the constituent societies can have associate members who obviously will never qualify for active membership in the A. A. O., Items 3 and 4 under Chapter XIV, Section 8 should be deleted, and perhaps Items 1 and 2 should be reworded. Many members think that it is a mistake to make provisions for associate members who cannot go on to active membership, even if they are allowed to retain this associate membership for a period of only a few years. These members believe that associate membership should be used solely as a steppingstone or preliminary to active membership.

EDUCATION COMMITTEE

The Chairman of the Education Committee, in making his report last year, stated that a survey of educational programs now being offered in the field of orthodontics had recently been compiled by our Committee with the

help of the secretary of the Council on Dental Education of the American Dental Association. The Committee recommended that a detailed study of the results of this survey be made and reported fully at the 1958 session.

In making its report this year, the Committee has tabulated in quite some detail the results of this survey. It has also called attention to the Workshop in Orthodontics which is to be sponsored by the W. K. Kellogg Foundation Institute of the University of Michigan. This will be held during the week of June 15 to 21, 1958. Several of the study groups of the Workshop are concerned directly with the task of this Committee.

The tabulated results of the survey and the additional information and ideas gained through the Workshop, in which the Committee will take part, should prove a real start toward standarization of educational programs in orthodontics. The Committee should be instructed to continue its efforts in cooperation with the council on Dental Education to bring about, as speedily as possible, a basic standardization and definite establishment of minimum requirements in this field.

OFFICE OF SECRETARY-TREASURER

Three years ago, at the San Francisco session, when making my report as secretary-treasurer of our Association to the Board of Directors, I had quite a bit to say about that office. I believe now, even more strongly than I did then, that the Association has grown to a point where serious thought should be given to finding someone, preferably one of our own members, capable of filling the position of secretary-treasurer on at least a half-time basis. Within a very few years it most likely will require full-time attention. In addition, as at present, the secretary-treasurer should have adequate full-time clerical assistance.

What I am saying is not to be construed as criticism of my predecessor in that office, Dr. George R. Moore. I have nothing but the greatest respect and admiration for the efficient and sacrificial services he rendered as secretary-treasurer. Nor are my remarks critical of the present incumbent of the office. I believe that Dr. Shepard is carrying on the present duties of secretary-treasurer in a most efficient manner.

Over the past decade or two, from time to time, many details have been added to the responsibilities of the secretary-treasurer, and a number of these require many hours for fulfillment, but the basic concept of the office has not been changed. This is what I believe should be considered, and considered very carefully. If a change is deemed desirable in the future, and if our present secretary-treasurer does not feel able to continue for a longer period, a search for a well-qualified member willing and able to assume the office with the added responsibilities should be made.

PROGRAM MANUAL

As a result of a recommendation by Dr. Philip E. Adams, in his president's address in 1956, a committee was formed, with Dr. C. Edward Martinek as

chairman, to prepare a program manual to assist future administrations with the planning for and conduct of our annual sessions. A preliminary report was rendered in New Orleans last year, and a further report is to be made this year.

These reports represent a tremendous amount of effort and time on the part of the Committee, particularly of its chairman, and the completed *Program Manual* will without question prove of inestimable value to future officers and the Program and Arrangements Committees. While this manual will serve as a pattern, it does not mean that it will be an inflexible one. From year to year minor changes undoubtedly will be necessary because of local conditions. I know that Dr. Martinek spent untold hours compiling all this material, and he and his Committee are to be commended for the splendid job they have done.

RELIEF

For a number of years the Association has maintained a Relief Committee, with the chairman serving also as a member of the Board of Directors. Fortunately, this has been an inactive committee. I do not believe that any aid has ever been granted, or actually requested.

It is true, of course, that all active members of the American Association of Orthodontists from the United States are also members of the American Dental Association and, as such, are eligible to request aid from the relief fund of the American Dental Association. I assume that the Canadian Dental Association also has a relief fund to which our Canadian members can apply. It would seem that our Association, in setting up our own Relief Committee, had in mind the possibility of assisting those who might not be considered in dire enough circumstances to come under the American Dental Association program or else intended to contribute over and above the payments made by the American Dental Association.

While there apparently has not been any real need for this Committee in the past, the Association has grown in members to a point where, if the Committee is to be continued, its purpose and duties should be much more clearly detailed and defined. Consideration might also be given to establishing a relief fund by designating a specified amount from the Association's reserve, by contributions or both.

It is my recommendation that a special committee be appointed by the incoming president to study the whole question of relief, including the desirability of continuing or discontinuing the Relief Committee, and to report its recommendations at the 1959 session.

CONVENTION PLANNING

Several years ago a Convention Planning Committee was added to the list of standing committees. This committee has never really functioned as intended. This is not meant as criticism of the men who have served on it. The reason, I believe, stems from the fact that ours is an association made

up of eight constituent societies. We do not have a headquarters to organize and conduct our annual sessions, and so the responsibility for doing this rests with the particular constituent in whose territory the convention is to be held. This, I believe, is desirable and adds interest to the sessions. Particularly with the help of the new *Program Manual,* about which I have already commented, and the added duties suggested in the secretary-treasurer's office, I am confident that every constituent will be able to continue to conduct interesting and successful sessions.

I do not believe that selection of a site should be made unless the particular constituent involved has extended an invitation to hold the session in the city of its choice. Each constituent, especially with the help of the *Program Manual* and the A. A. O. secretary-treasurer, should be able to ascertain whether the hotel of choice and its accommodations are adequate.

Following the invitation by a constituent to hold a session in a definite city, there is almost certain to come a nomination for one of its members to serve as president. I believe that this will hold true now that we are selecting five years in advance just as much as it did when the decision was for only three years.

There are, of course, possibilities of a contest for the office, and it may develop that the successful candidate will be from a different constituent than that in which the selected site is located; nevertheless, I still believe that there is not too much likelihood of this happening. Should it come about, however, it would simply mean that for this particular year the president would not be able to hold the annual session within the territory of his own constituent society. I am confident, though, that he would receive the cooperation of the members in the vicinity of the selected site.

I believe, with a number of members who have served on the Convention Planning Committee, that there is really not any need for this Committee and, therefore, I recommend its discontinuance as a committee of the Association.

CREDENTIALS COMMITTEE

With the increase in membership and size of our sessions, it has become more evident that something further must be done about our policy of guest attendance at the annual sessions. This particularly applies to the meetings devoted to clinics and the Round-Table Discussion Luncheon.

Several years ago, to lessen the problems of the Registration Committee at the time of the session and to facilitate the advanced registration of guests, a Credentials Committee was formed. The guests, other than those participating in the program, were divided into three principal categories ("A," "B," and "C"). Detailed explanations of these categories have been published each year in the JOURNAL.

Guests coming under the "A" and "B" categories do not present any particular problem. Category "C," however, is a different matter. In anticipation of a large number of "C" applications at the 1958 and subsequent

sessions, it was voted to require that all requests by dentists coming under this "C" category must be received by the chairman of the Credentials Committee sixty days before the session and that registration under this category should be limited, regardless of the sixty-day deadline.

This year the limit set for this guest registration was reached and surpassed long before the sixty-day deadline. Numerous letters of protest or requests for special consideration were received from members interceding for dentists whose requests for admittance had been declined by the Credentials Committee. Because this is the first year that any serious effort has been made to limit the guest registration, and because of the large number of letters and phone calls, it was decided late in March to accept all those whose completed application forms had been returned to the chairman of the Credentials Committee by March 1.

It is my recommendation that Section 11, Chapter XIV, of the by-laws be deleted and that next year's Arrangements Committee, in conjunction with the Credentials Committee, be again given the authority to limit the number of guests in the "C" categories. Perhaps after assessing the experience of these two years, 1958 and 1959, it will be possible to establish more definite guest regulations.

COMMITTEE MEETINGS

Of the twelve standing committees whose chairmen serve as members of the Board of Directors and the three or four additional committees, few ever actually hold meetings, and only a couple committees hold a meeting every year. It is true that most of the work of these committees can be carried on by correspondence; nevertheless, it would be most desirable if all committees met on the Saturday before the opening of our annual session, or for an early breakfast on Sunday preceding the Board of Directors' meeting, which usually starts at 10 A.M. It might be well at these presession meetings if the purpose and duties, as printed in the by-laws, of the particular committee concerned were read to refresh the mind of each committee member.

Then, following the Tuesday or Thursday business meeting of the Association, all those committees which are supposed to elect their own chairman should meet again with the newly elected member and decide who is to serve as chairman for the ensuing year. The retiring chairman should also arrange this second meeting. If a chairman of a committee cannot attend the annual session, he should delegate one of the other members of the committee to arrange and conduct these meetings. When the selection of the new chairman is made, it should be reported promptly to the secretary-treasurer.

It is my recommendation that this suggested plan for committee meetings be adopted and that early in the next administration the secretary-treasurer notify each chairman as to what is expected of him with regard to holding meetings and inform him of any particular assignment which has been referred to his committee for consideration or action. The secretary-treasurer should

also supply the chairman with a copy of the verbatim minutes pertaining to any such assignments. It is further recommended that a critical study be made of the entire standing committee structure of the Association to ascertain whether or not all are truly serving a useful purpose in the Association's interest.

ORTHODONTIC PROFILES

During the past two years the AMERICAN JOURNAL OF ORTHODONTICS has been publishing a series of "Orthodontic Profiles." These are biographical sketches of outstanding leaders in the field of orthodontics who, at varying periods over the past fifty or more years, by their personalities and talents, did so much to establish the specialty of orthodontics and keep it traveling on the road to its ultimate destination.

The editor in chief and his staff, as well as the individual authors of these profiles, are to be congratulated on this series of sketches which have so greatly enriched the orthodontic literature and have added much to the attractiveness of the JOURNAL.

Orthodontics, measured in terms of history, is a very young specialty, but it is endowed with a rich heritage. We should be jealous of this legacy and ever guard against those from within or without who, for some selfish reasons, would lower its high purposes and standards.

In 1915 Dr. Charles Mayo made a statement to the effect that there was a young, but growing, branch of dentistry known as "orthodontia," and he predicted that it was destined to become one of the great branches of preventive medicine.

Are we individually and collectively directing the affairs of our specialty, our practices, and our lives toward making the validity of this prediction more generally recognized?

As in all other walks of life, changing conditions have made their impact on the professions as well. Many, with good reason, are worried about present trends in our own specialty. When we learn of the clamor among increasing numbers who want to take short courses to learn to treat orthodontic patients, and when we know that it cannot be adequately accomplished in this way, our concern is justified. Further, the realization that of the bands, brackets, wires, and other materials so beautifully described and illustrated in the advertisements and so necessary for the construction of orthodontic appliances, the large majority are sold to general practitioners, certainly does not lessen this concern.

When talks are given for general practitioners who evince an interest in orthodontics, if they desire to do more than what might be called preventive orthodontics, efforts should be made to convince them that much more thorough and concentrated study must be devoted to the subject than can possibly be gained by so-called short courses or seminars. This view is not taken because of a selfish desire on the part of those who practice the specialty exclusively to

keep this work for themselves, as is so often charged. It should not be necessary for me to remind you that orthodontics is considerably more than the ability to use one's hands dexterously. In one of his addresses, Dr. Harvey Cushing, the brilliant neurosurgeon, stated that he would like, some day, to see some medical school appoint, as its professor of surgery, a physician who had no hands. How well these same implications apply to the teaching of orthodontics!

What, then, should the general practitioner do in the way of diagnosis and treatment? There is no reason, as I see it, why he should not undertake whatever his training truly qualifies him to undertake—a restriction, incidentally, that applies to all of us, whether we are members of this Association or diplomates of the American Board of Orthodontics. The privilege to practice within special fields is not solely a matter of licensure and credentials. The possession of these documents gives the dental graduate the legal right to undertake orthodontic work for anybody ignorant enough or foolish enough to permit him to do so. I should not have to remind you that that fact carries with it certain moral implications for those who practice orthodontics. When we speak of the treatment of orthodontic cases by those who have no right to do it, we must direct our attention to our own household also. There is a great need for improving the public's understanding of the aims of our specialty.

Orthodontics at this moment is passing through a transitional stage in its development but, despite the reasons for concern which have been mentioned and others apparent to those who occasionally pause to take stock, it is my firm conviction that if we can properly discipline ourselves and adjust to the changing socioeconomic demands, the future looks very bright indeed and orthodontics is destined to be universally recognized in its rightful place among the cultural and health service professions. I also have an abiding faith that this still-growing specialty will always be in as strong hands as were those which guided it through the first half-century of its existence.

Before bringing this address to a close, I want publicly to thank all the officers, committee chairmen, and members who have done so much and given so freely of themselves to aid this administration in its endeavors and to bring into being this fifty-fourth annual session.

I shall not indulge in naming names, as pleasant as that might be, of all those committee chairmen to whom I shall always owe a debt of gratitude. The list would be far too long for inclusion. I trust that it will suffice at this time to thank two men, Drs. John R. Thompson and Wilbur J. Prezzano, Program and Arrangements Committee Chairmen, respectively, and, through them, the various chairmen and members of the local committees.

This year the Research Section is dedicated to the memory of Thomas D. Speidel, who served as chairman of research until his sudden death last November. Dr. Speidel contributed generously of his exceptional talents to the profession through his teaching, writing, and research. To know Tom Speidel was to love him; his smile was contagious. It will be difficult indeed to replace him. He is sorely missed.

To the vice-chairman, Dr. Beebe, the local treasurer, Dr. Howes, and the local committee chairmen who individually and collectively have worked so diligently over the past several months, my most grateful thanks. Our sincere appreciation is also extended to the essayists, clinicians, exhibitors, and others without whose participation the session could not be held. And last, but I can assure you by no means least, our humble appreciation to our good friend and counselor, Mrs. Augusta Grimm. To anyone conducting a professional meeting, it is always a very comforting experience to see Mrs. Grimm seated in front of the rostrum, recording the proceedings.

I thoroughly appreciate the confidence expressed in me by my election as your president for this past year. It has been a real privilege and a signal honor to have this opportunity to be of service.

HEREDITY AND THE CRANIOFACIAL COMPLEX*

BERTRAM S. KRAUS, PH.D., WILLIAM J. WISE, D.D.S., AND
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INTRODUCTION

AS WITH most disciplines, research in orthodontics follows two lines—the applied and the basic. Basic research in cranial morphology is primarily concerned with two broad fields of inquiry. One is centered about the question: "What are the patterns of craniofacial growth that characterize the human species and its varieties, and what are the characteristics of human ontogenetic growth that can be associated with adult craniofacial individuality?" The second may be stated: "What is the role of the genetic constitution in the craniofacial complex as presented to the orthodontist?" From the research carried on in growth and heredity, the orthodontist rightfully expects to acquire new and modified concepts that will bear directly upon his methods of diagnosis, treatment, and prognosis.

In this article our concern is with the field of heredity as it applies to orthodontics. We shall restate certain concepts that are fundamental to all research in genetics and examine their applicability specifically to the craniofacial complex. After brief mention of typical approaches in genetics, we shall concentrate upon one in particular, namely, the zygosity method. Since this method has been followed quite frequently by workers in the field of orthodontics, the results of their work will be critically examined. Some of the essentials of the zygosity methodology will be set forth. We will then examine some of the analytic methods employed as clinical and classificatory devices in order to determine their compatibility with genetic concepts and to decide whether or not these methods are suitable for defining heritable traits. A method for the study of inheritance in the craniofacial complex will be suggested.

PROBLEM

An investigation into the heredity of the craniofacial complex must, on the one hand, follow accepted methodological procedures of genetic research and, on the other hand, make clear-cut decisions as to which aspects of the craniofacial complex are clinical constructs and which are anatomic realities. These two lines of investigation will immediately raise a number of questions

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which must be satisfactorily answered if the major problem is to be resolved. The major problem posed in this article may be stated as follows: "Is the craniofacial complex, either as a whole or in its component parts, under the discernible control of the genetic constitution?"

In the statement of the problem we use the words "discernible control" since there can be no question that the growth process itself is under genetic control.[13, 46] In the phenotype, however, which is the end result at any given moment of the cumulative effects of interaction between the differential growth processes and changing environments, are there discernible evidences of hereditary influences? In other words, although there is constant interplay between heredity and environment, can the predominant influence of one or the other be demonstrated? Genes do not work in a vacuum; nor does an environment produce a man without a human genotype to begin with! For these reasons, then, any trait that we choose to recognize—be it a blood antigen, the length of the tibia, the deposition of subcutaneous fat, the shape of a bone, the mandibular angle, or the cephalic index—is the ultimate product of genetic and environmental interaction *ab ovo*.

It is further recognized that these so-called traits are, in a very real sense, arbitrary. There is no gene or group of genes whose primary effect is to achieve a certain length of bone, a certain angle, or a given morphology. In fact, with very few exceptions, primary effects of genes are not known.[10, 14] If the "residual pattern" of gene action[15] cannot be observed, the differential pattern can be. The farther we get from primary effects, however, the less apparent is the role of the genes. Our efforts should be directed toward identifying "least common denominators" of the craniofacial complex, keeping in mind that even these elements are far from primary effects. The properties of such elements of the craniofacial complex are the result of chains of biochemical reactions catalized presumably by genes,[3] and before any of these genes can reproduce many other genes must have gone into action. As Beadle[3] states, the organism is "a complex and highly integrated system in which reactions are systematically related in both time and space." An important question is then raised: What components of the craniofacial complex will manifest genic action and control?

We then are faced with the problem of method. What means do we have of recognizing genic control of a phenotypic trait? Since our chief concern is to learn whether a trait is governed predominantly by the genetic constitution rather than by variable environmental factors, the twin method seems most appropriate. The methodologies developed in population genetics and pedigree analysis are directed more toward the discovery of the genetic mechanism involved in inheritance. The principal objective of twin studies has been the estimation of heritability, although diovular twins may aid in the detection of simple modes of inheritance.[41]

The inherent value of the twin method lies in the fact that monovular twins, triplets, or quadruplets possess identical genetic constitutions. Diovular twins or triovular triplets, since each member of the set originates from a separate zygote, are genetically as similar or dissimilar as are siblings of different ages. Phenotypic differences between monovular persons must be the result of environmental

influences or of interaction between identical genes and different environmental factors. Monovular persons are obviously of the same sex. Polyovular persons may be of the same sex, or both sexes may be represented.

In addition to the fact that identical genetic constitutions can be contrasted with dissimilar ones, a further control can be exercised by choosing fraternal sets in which the members are of the same sex. Differences between litter mates due to sex can then be cancelled out. In summary, the use of litter mates (both monovular and polyovular) permits the important variables of age and sex to be disregarded. Differences between litter mates in prenatal environment are reduced to a minimum, but not eliminated, and presumably phenotypic differences between monovular litter mates then indicate the effect of intrauterine or postnatal differences in environment. However, we are, to quote Price,[37] "after-the-fact observers of the results, and are left to guess what environmental factors nature put into the experiments." It must be emphasized that environmental differences do exist for litter mates. Price has called these differential environmental factors *primary biases* and defines them as "prenatal and natal environmental factors peculiar in kind or degree to twins." These he classifies as (1) *natal factors,* which includes placentation, position in utero, crowding, and delivery, (2) *lateral inversions,* comprising all degrees of asymmetry reversal, and (3) *mutual circulation,* which concerns the after effects of the mutual circulation in monochorial fetuses. In other words, differences observed between monovular persons may be due not to postnatal environmental factors but to prenatal factors peculiar to litter mates and, in some instances, to monochorial litter mates in particular. The effect of these biases is to obscure the heredity factor or to overemphasize the importance of postnatal factors.

Obviously, if conclusions as to heritability are to be drawn from twin studies, the determination of zygosity is of paramount importance. Examination of the fetal membranes is not conclusive in all cases.[36] Only monovular sets have a single chorion, but some may have more than one. Polyovular sets never have a single chorion or amnion. All monovular sets have a single placenta, but many polyovular sets also have a single placenta. Usually by the time twin studies get underway the data concerning the afterbirth either are not available or their reliability cannot be checked. Other methods must be used to determine zygosity. It must be emphasized that monozygosity cannot be diagnosed with absolute certainty with the present available techniques. Polyzygosity can be diagnosed positively in a majority of cases. The probability of monozygosity can be estimated, however, and should be stated for each case wherever litter mates are used for the study of inheritance. Basically, the diagnosis of zygosity depends upon similarity tests. The more reliable of those tests utilize phenotypic traits whose heritability has been demonstrated and whose mode of inheritance is understood. Such traits are the various antigenic groups found in the blood and the ability to taste phenylthiourea. In this article we shall demonstrate the use of certain inherited serologic traits and of the PTC-taster trait in indicating dizygosity and in estimating the probabilities of monozygosity. Of second-order ranking in the diagnosis of zygosity are those traits whose heritability has been

demonstrated but whose precise genetic mechanism is not yet understood. These include certain morphologic structures of the dentition and patterns of ridges on the fingers (dermatoglyphics). Other traits, which might be termed third-order variables, consist of gross dimensions and general morphologic characters whose heritability is obviously complex and is often masked by environmental factors.

The use of triplets of the same sex presents certain advantages over the use of twins. Triplets may be of three types: monovular, diovular, and triovular. In the case of diovular triplets, the monovular twins may be compared with a litter mate of different genetic constitution. In triovular triplets the probability of underestimating environmental influence is reduced, while in monovular triplets the probability of overestimating heritability is reduced. These distinctions will be pointed out as they occur.

As will be discussed in the following section, the question of heritability of the craniofacial complex and its various components has acquired a prominent place in the orthodontic literature. Both pedigree analyses and twin studies have been utilized in attempts to come up with answers. It is unfortunate that with regard to many of these attempts there is "little or no controlled observation; there is mostly speculation, philosophizing and conjecture."[26] Perhaps an important contributing factor in the failure of many workers to achieve more definitive results lies in the very nature of the phenotypic criteria whose heritability they are attempting to assess. Again, this brings us back to our original problem. Granted that heredity plays a role in establishing the phenotype, either in whole or in part, we much nevertheless break down each organic complex into those constituent elements which will reflect the influence of heredity when this influence is predominant over the environment. Genes play a role in the achievement of the individual's stature and body build. Beyond this generality, we can expect little that is more specific as to the degree of heritability or the genetic mechanism involved. Since each trait is really an expression of all the elements of the organism, we soon find ourselves in a cul-de-sac as far as genetic enlightenment is concerned. In the same way, we must be aware that the craniofacial complex is indeed just that—a complex. Furthermore, we may subdivide it into various subcomplexes, such as the dental, the maxillary, the cranial base, etc., each of which in turn consists of many elements. The very nature of genic action, as far as geneticists understand it at the present time, precludes the notion that any such complex has a simple genetic determinant or that, indeed, its heritability can be accurately assessed. Why, then, should we continue along this path? Why not reduce the craniofacial complex to its smaller heritable elements, if this be possible, and thereby establish a sounder foundation for our understanding of the role of heredity?

In summary, our major problem is to determine whether the craniofacial complex, either as a whole or in its component parts, is under the discernible control of heredity. The twin method of estimating heritability will be followed in modified form by using triplets. The problem of zygosity diagnosis will be demonstrated and the value of various similarity tests will be indicated. We shall briefly examine some of the contributions of workers in this field and test some of their conclusions with our data. An attempt will be made to distinguish

between aspects of the craniofacial complex which are not amenable to genetic investigation and those elements which hold promise for better understanding of the role of heredity.

STATUS OF THE PROBLEM

In a recent summary of the research on the hereditary basis of various aspects of the craniofacial complex, Krogman and Sassouni[26] make the following statement:

> The really great problem—the central core of the issue—is whether or not we can say (as we observe a specific case of malocclusion) "this is genetics, i.e., this is inherited."

Previously they had asked similarly phrased questions, such as: "Is malocclusion inherited?" and "What are the factors of genetic origin that predispose to malocclusion in Man?" The authors themselves feel that the latter question is "more properly" put, and with this we agree. There can be no question that the clinical entity that is designated "malocclusion" is the end product of the interplay of biochemical processes, physiologic functions, and growth dynamics with each other and with the changing environment through time. And there can be no question that many of these processes, functions, and dynamics are under strict genetic control. Genetics certainly is involved in predisposing a person to either good occlusion or malocclusion. Occlusion itself, however, is no more a unit of inheritance, such as the pigment melanin or the blood antigen Rh, than is stature, body build, or temperament. Since similarly classified malocclusions may come about in quite different ways, it is misleading to ask, "What are the factors of genetic origin that predispose to malocclusion?" We prefer "What elements of the craniofacial complex involved in occlusion and its variable manifestations are predominantly under gene control?" The answers to this question will not lead us directly into an understanding of all the forces at work in achieving occlusion, good or bad, but they will provide a sound beginning.

When malocclusion is regarded as a unit character or anatomic entity, then we find researchers coming up with misleading interpretations or with the "speculation, philosophizing, and conjecture" which Krogman and Sassouni have noted. As an example, Moorrees, in a study of the Aleut dentition in 1951, indicates that a genetic study by Osborn of the incidence of Class III occlusion in the Eastern Aleut has resulted in the hypothesis that "a single recessive gene suffices to explain the incidence of excessive mandibular prognathism." In a later monograph on the same subject, Moorrees[33] again refers to this genetic study and its interpretation of simple Mendelian inheritance of Class III malocclusion. In a more recent summary of his findings on Aleut dentition, Moorrees states:

> In the families studied, this particular skeletal disharmony (Class III malocclusion) seems to be determined by a Mendelian recessive gene, while in whites it appears to be determined by a Mendelian dominant.

To our knowledge, the supporting evidence for these statements has not been published.

Iwagaki[20] made a statistical study of a Japanese population, using more than 2,000 family histories. His interest was centered upon progenia, which includes both mandibular protrusion and edge-to-edge bite. He concluded that both conditions are familial, that is, they show some evidence of heritability. He then tentatively suggested that the inheritance is due to a Mendelian recessive but admitted that his statistics did not support this interpretation!

Rubbrecht[43] studied mandibular prognathism and maxillary retrognathism in eight family lines. He concluded that these two conditions are "dependent on heredity, as a rule." In spite of this admission that there are not consistent manifestations of heritability, Rubbrecht claims that the mode of inheritance is "irregularly dominant." In addition, he points out that the shape and size of the jaws are "in great measure determined by heredity."

The work of Hughes and Moore[17] must be carefully scrutinized, since it has been frequently quoted in the literature and has had a widespread influence on thinking in the field of heredity and orthodontics. Their studies are based upon a group of 554 persons representing 150 families. Their results are stated in terms that are extremely difficult to translate genetically. For example, it is claimed that "hereditary circumstances provide fully 85 per cent of the variation shown in the dentition and in its growth." It is important, they say, in the examination of a person, to know "whether 50 per cent of a particular type of malocclusion can be ascribed to nurture, 20 per cent to heredity, and 30 per cent to an interaction between the two, or to know that another type of malocclusion has an 85 per cent foundation in heredity." How shall we interpret the statement that, with regard to asymmetries and displacements, "genetic factors appear to have the edge"? In a similar type of generalization drawn from his extensive data, Hughes[18] concludes that his investigation of the dentofacial complex has "revealed the extensive operation of heredity factors which contribute to the formation of normal occlusion and malocclusion" Moore[32] has nothing more definitive to add. He states: "Heredity background is unquestionably present in these types of malocclusion." Hughes does not limit himself to sweeping generalities. He claims that "palate height has a single gene, while palate width has multiple genes."[19] Hughes' credo is in the genetic independence of parts, even to the extent that growth complexes within the individual bones are claimed to be independently controlled by heredity! This in spite of the abundant evidence offered by the allometrists:[2, 8, 34, 39] that a single pattern applies to all bone growth!

Stockard[49] and Johnson[21] both made far-reaching statements concerning the genetic independence of the various components of the craniofacial complex. These are ably summarized by Krogman and Sassouni.[26] Weidenreich,[51] however, in his brilliant monograph on the evolution of the skull, holds that the craniofacial structure is a closely knit complex of genetic interrelationships.

A survey of the literature thus far mentioned leads us to a conclusion that may be best stated in the words of Krogman and Sassouni[26]: "It is fair to conclude, up to this point, that genetics is operative in the dento-facial complex."

Since this is a conclusion that is easily arrived at on the basis of theoretical genetics, we do not feel that much progress has been achieved.

A number of students have utilized twin studies in attempts to assess heritability of various components of the craniofacial complex. Goldberg[12] studied biometrics in fifteen pairs of "identical" twins. Diagnosis of zygosity was made by Newman, who used five criteria: (1) a single placenta, which was regarded as "incontrovertible," (2) an impression of great resemblance or "identity to the visual senses,"* (3) anthropologic measurements which should not show "too considerable differences," (4) configuration of the ears, (5) dermatoglyphics, and (6) eye and hair color. Goldberg confined his attention mainly to the environmental effects upon individual teeth, his observations being metrical rather than "visual." He felt that environment normally did not exercise a very great role in the determination of arch form.

Snodgrasse[47] studied cephalo-facial growth in a family line which included one pair of twins. He pointed out a number of close resemblances between the two twins and concluded that "this is what one would expect in presumably identical twins." Bonello[4] made a cephalometric appraisal of thirty-nine "identical" twin pairs between the ages of 6 and 14 years. Zygosity in each case was "established" either by correspondence with the physician in attendance at the delivery or by statements by the parents. Bonello then goes on to "determine if the various measurements used in this study are differentially influenced by heredity and environment." His argument is apparently based on the assumption that similarity of traits in identical twins proves predominant genetic influence. Without comparable variances in fraternal twins, there can, of course, be no reliable conclusions. For example, he suggests that since the twins are highly correlated in the degree of malocclusion, then "occlusion or malocclusion is influenced more by genetic variables than by environmental variables." Since doubt must be cast on the reliability of his twin diagnoses and since proper controls, in the form of fraternal twins, are absent, this statement has little basis.

In a study of craniofacial patterns, Wylie[53] used a sample of fifteen families, thirteen of which included a twin pair of like sex. No attempt was made to determine zygosity in these twins. Nevertheless, Wylie expressed surprise that in ten pairs showing great intrapair resemblances in outward appearance, the twelve craniofacial angles studied showed striking differences. In the same paper he predicts that his method will "come into sharper focus" when applied to a "group of twins already classified as monozygotic or dizygotic." Wylie's conclusions are significant. He found that:

> None of the angles studied bears a relationship to any other angle in the craniofacial complex that is precise enough to be predictable. Furthermore, no definite relationship between any particular angle and any particular side of the polygon can be said to exist; and, finally,

*Goldberg states (p. 375): "It may be said that the visual sense is more accurate in scrutinizing differences and similarities than any objective laboratory measurements can be."

> knowing that one particular side is relatively long or relatively short does not permit one to prediet even roughly the length of any other side.

We are not told why this method is "particularly useful in the study of resemblances in a family, and in studies of twins." Since the degrees of similarity or dissimilarity between unrelated persons were not obtained, there is no way to determine whether angular measurements follow family lines. If we recall accurately our plane geometry, there is no correlation between one angle of a polygon and any other angle of that polygon, and, without knowing some of the angles, varying the length of one side will not allow prediction of the length of any other side.

Brodie and Newman[6] studied a set of adult male triplets and concluded, on the basis of finger- and palmprints, handwriting, personality ratings, cephalometrics, handedness, and somatometry, that two of the members were monozygotic. Bodie superimposed lateral head and face tracings and also compared frontal tracings of head outlines. He compared these with similar data obtained from "sibling controls." A glance at his illustrations suggests that superimposition of *total* head outline tracings will provide no information as to the role of heredity. Brodie's work is definitely a step in the right directon. It is regrettable that he did not continue his investigations along these lines.

In his study of tooth size and occlusion, Lundström[29] utilized a sample of 100 monozygotic and 102 dizygotic pairs of twins of like sex. In a review of this work, Walker[50] criticized the method of determining zygosity, since Lundström did not use either blood groups or dermatoglyphics. She claimed that this meant that "there was some doubt concerning the zygosity of at least 11 per cent of the monozygotic twins, and, with a possible error of even less than this, the careful statistical analysis which follows loses much of its point." In a later work, in which fifty pairs of twins were identical and fifty were fraternal, Lundström[30] indicated that in fourteen of the pairs "blood grouping was performed for the A-B-O, M-N, Rh, C-D-E [sic], S, and P factors and in none of these pairs did this analysis contradiet the results obtained by the similarity comparison." Since identity of these blood group factors between twins does not necessarily indicate monozygosity but rather reveals a probability of monozygosity, and since the probability can be estimated only if the parents' blood groups are known, we cannot regard the conclusions drawn from this study as any more reliable than those of the earlier work. Lundström's conclusions are of a general nature. In fact, he points out that any general conclusions are not warranted with regard to overjet and overbite. His calculations seem to indicate, however, that "genetic factors have a greater influence than nongenetic factors" for most of the craniofacial distances and angles studied. Many of the angles and diameters which Lundström employes are identical to those used by Wylie.

Leech[28] studied a pair of monovular twins, one of whom exhibited a Class II, Division 1 malocclusion while the other had a Class II, Division 2 malocclusion. Using blood grouping on both twins and parents, Race and Sanger[38]

determined that the odds in favor of monozygosity were 200 to 1. On the justifiable assumption that the twins were indeed monovular, Leech advanced the hypothesis that differential muscle behavior patterns were responsible for the different types of malocclusion. Analysis of muscle behavior was based upon electromyography.

From this brief review of some of the research into the problem of heredity and its influence on the craniofacial complex, we must conclude that there is much that is general and obvious and very little that is definitive and supported by real evidence. The field is still wide open for investigation.

METHOD

Six sets of triplets of the same sex provide the data for this study. Their identifying set numbers, together with sex and age, are as follows:

Set Number	*Sex*	*Age at Time of Examination*
103	Male	11 years, 10 months, 27 days
106	Female	11 years, 7 months, 13 days
107	Male	11 years, 9 months, 18 days
108	Male	15 years, 8 months, 18 days
109	Female	14 years, 9 months, 19 days
111	Male	9 years, 3 months, 11 days

The following types of data were obtained for each person:

1. *Blood group systems.* Three cubic centimeters of blood was drawn by venipuncture from each subject and sent to the King County Blood Bank, where each specimen was tested for the following blood groupings:

Blood Group System	*Serum Antibodies Used*
ABO	Anti-A, anti-B, anti-a_1
MNSs	Anti-M, anti-N, anti-S, anti-s
Rh	Anti-C, anti-c, anti-D, anti-E
P	anti-P
Kell	anti-K
Duffy	anti-Fy^a
Lewis	anti-Le^a

The parents of five of the six sets of triplets were also typed. The parents of set No. 106 were not available.

2. *Stature and weight.* Stature was recorded with the subject's shoes removed and with the head oriented in the Frankfort horizontal plane. Weight was recorded with only the shoes removed.

3. *Front and lateral head photographs and headfilms.* The subject's head was oriented in the Frankfort horizontal plane by means of a mounted Western Reserve type of head spanner. Frontal and lateral roentgenograms were taken with the head oriented in a Broadbent-Bolton roentgenographic cephalometer.

4. *Front and lateral group photographs in color.*

5. *Dental impressions and casts.*

6. *Fingerprints.* These were taken on a Faurot fingerprint inkless pad and impressed on Faurot sensitized paper. Prints of all the fingers were made.

7. *Taste sensitivity to PTC.* A stock solution of 0.13 per cent phenylthiourea was made up, and seven serial dilutions were prepared according to the specifications given by Harris and Kalmus.[16] An eighth test tube contained plain tap water. Each subject was given a few drops of water first and then started on the PTC solutions, the weaker solutions first. The number of the solution which first cause a definite taste reaction was recorded. If no strong reaction to any of the solutions occurred, the subject was identified as a nontaster. Because of the many possible biases present, including the uncertainty as to what level should be recorded in some cases, only two categories were retained—those of taster and nontaster.

The members of each triplet set were labeled with the letters A, B, and C in order to identify them as individuals.

Zygosity was coded in the following way:

1 = Individuals A and B are monovular.
2 = Individuals B and C are monovular.
3 = Individuals A and C are monovular.
4 = The individuals are triovular.
5 = The individuals are monovular.

The same code was also used to designate phenotypic identity or similarity. Thus:

1 = Individuals A and B are identical or more similar than are pairs B-C or A-C.
2 = Individuals B and C are identical or more similar than are pairs A-B or A-C.
3 = Individuals A and C are identical or more similar than are pairs A-B or B-C.
4 = No pair is identical, or the three individuals are about equally dissimilar.
5 = All three are identical or very similar.

Since the line between qualitative and quantitative traits is arbitrary rather than real, the term "identity" must be defined in each instance. In this article, the term "identity" will be used only in connection with the blood groups. Two persons who belong to the blood group A_1 will be called identical with respect to this trait. On the other hand, if they both weigh 58¼ pounds, they will be called similar, due to the inherent error in observing this trait.

DIAGNOSIS OF ZYGOSITY

Blood Group Data.—For the sake of brevity, one set of triplets (set No. 107) and their parents will be used to illustrate how the data obtained from blood group analysis may be used in making zygosity determination on the basis of probability. A more detailed account may be found in the book entitled *Human Heredity* by Neel and Schull.[35]

Table I presents the results of agglutination tests on both parents and triplets of Set No. 107. From these results, it is very often possible to determine the genotypes of some, if not all, of the individuals involved. This is demonstrated in Table II. With regard to the ABO system, the mother can have only

TABLE I. RESULTS OF AGGLUTINATION TESTS ON FAMILY OF TRIPLET SET NO. 107

SUBJECT	ABO GROUP	ANTISERUM											
		C	c	D	E	M	N	S	s	K	Fy^a	P	Le^a
Father	A_1	+	+	+	−	+	+	+	−	−	+	+	−
Mother	O	+	+	+	−	+	+	+	−	−	+	+	−
Sibling A	A_1	+	+	+	−	+	+	+		−	−	−	−
Sibling B	A_1	+	+	+	−	+	+	+		−	−	−	−
Sibling C	O	−	+	−	−	−	+	+		−	+	−	−

the genotype OO, but the father may be either A_1O, A_1A_1, or A_1A_2. All children of this union must each have at least one allele derived from the mother. Sibling C, however, is a homozygote with two O alleles. Hence, the other O must have derived from the father. The father is therefore the genotype A_1O. The other two siblings (A and B) have the phenotype A_1, but since the A_1 allele can have derived only from the father, each must be a heterozygote, having received an O from the mother. For the ABO system, then, we can be certain of the genotypes of all five persons. Additional explanation of this point may be found in the work of Lawler and Lawler.[27]

For the Lewis system, only the anti-Le^a serum was used. A positive reaction would indicate the phenotype Le (a+b−) and the genotype Le^aLe^a, but a negative reaction fails to distinguish between the genotypes Le^aLe^b and Le^bLe^b. This was the case with all members of family No. 107. Hence, only the phenotypes are indicated—Le (a−).

Both parents gave positive reactions to the Duffy anti-Fy^a serum. This means that both have the phenotype Fy (a+) which could result from the genotype Fy^aFy^a or the genotype Fy^aFy^b. Since siblings A and B reacted negatively and hence have the phenotype Fy (a−) and the genotype Fy^bFy^b, both parents had to have the allele Fy^b. The parents are thus established as heterozygotes with respect to the Duffy locus. On the other hand, sibling C gave a positive reaction and belongs to the phenotype Fy (a+), but it is impossible to determine whether he is a homozygote or a heterozygote. The genotypes for the other blood group loci are similarly determined where possible.

The next step is to estimate the probability of the three offspring of these parents having identical genotypes for all blood group loci tested by chance alone. For simplicity, only two loci are considered in Table III—the ABO and the Rh loci.

Two statements of explanation must be presented at this point. First, it is assumed in these determinations that there is no case of illegitimacy. Certainly, the blood group data gave no evidence of incompatibility. Second, dizygosity is immediately established if a single difference between two persons is found at any locus. For example, in triplet set No. 103, siblings A and B differ at the Rh locus, B and C differ at the ABO locus, and A and C differ at the Rh locus.

TABLE II

Triplet Set #107

Hence, there is no question that set No. 103 is a triovular (fraternal) one. On the other hand, identity of two persons in all the blood group genotypes considered fails to indicate dizygosity but is not proof of monozygosity.

Although we can never prove monozygosity beyond any question, it is possible to state with some accuracy the probability that any two or three persons with identical blood groupings are indeed monovular. The decision, then, rests upon acceptance of some level of significance in probability terms. For example, in many scientific experiments a 5 per cent level of significance is regarded as adequate. In other words, if it can be demonstrated that there is a 95 per cent probability or more that a certain event will not occur by chance, then it is generally accepted that the particular result achieved has not occurred by chance. Where unusual reliance must be placed upon the result, a 1 per cent level of significance is demanded. In this article we leave the choice of the level of significance up to the reader. If we can demonstrate that there is less than one chance in 100 that twins having the same blood groups are diovular, we feel that we can safely proceed in this study on the assumption that they are monovular.

TABLE III. METHOD OF ESTIMATING PROBABILITIES OF TWO AND THREE OFFSPRING IDENTICAL AT THE ABO AND Rh *LOCI*

	ABO LOCUS		Rh LOCUS				
			PHENOTYPE				GENOTYPE
	PHENOTYPE	GENOTYPE	C	c	D	E	(MOST PROBABLE)*
Father	A_1	A_1A_1 A_1O A_1A_2	+	+	+	−	R′r (0.937 of all bloods of this phenotype)†
Mother	O	OO	+	+	+	−	R′r
Possible offspring			+	−	+	−	R′R′
	A_1	A_1O	+	+	+	−	R′r
	O	OO	−	+	−	−	rr

*See Table 40 in Race and Sanger: *Blood Groups in Man*, ed. 2, 1954.[38]
†See Table 56 in Race and Sanger: *Blood Groups in Man*, ed. 2, 1954.[38]

Proceeding now to an examination of Table III, based upon the actual ABO and Rh phenotypes of the parents of set No. 107, we see that only two kinds of offspring, genotypically speaking, can result from a mating of A_1O with OO genotypes. On the other hand, matings of R′r genotypes can produce three types of offspring—R′R, R′r, and rr. Table IV indicates that the parents of set No. 107 can have two offspring identical for the ABO genotype 50 per cent of the time by chance alone and three offspring identical at this locus 25 per cent of the time by chance alone. Identity in this case means that all the offspring will be either OO or A_1O. In a similar way it can be shown that R′r parents will produce offspring in the expected ratio of one R′R′ to two R′r to one rr. The probability of having three successive offspring who are all R′R′ is $\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} = \frac{1}{64}$; for all R′r, it is $\frac{8}{64}$, and for all rr it is $\frac{1}{64}$. The sum of these separate probabilities, or $\frac{5}{32}$, gives the probability that three successive offspring of these parents will be of identical Rh genotypes by chance alone. The

TABLE IV. METHOD OF ESTIMATING PROBABILITIES OF TWO AND THREE OFFSPRING IDENTICAL AT THE ABO AND Rh LOCI

	ABO LOCUS	Rh LOCUS	
Probability of two identical offspring	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$	$\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$	
	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$	$\frac{1}{2} \times \frac{1}{2} = \frac{4}{16}$	$\frac{1}{2} \times \frac{3}{8} = \frac{3}{16}$
	$\frac{1}{2}$	$\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$	1 chance in 5.3
		$\frac{6}{16} = \frac{3}{8}$	
Probability of three identical offspring	$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$	$\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} = \frac{1}{64}$	
	$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$	$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{8}{64}$	$\frac{1}{4} \times \frac{5}{32} = \frac{5}{128}$
	$\frac{1}{4}$	$\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} = \frac{1}{64}$	or
		$\frac{10}{64} = \frac{5}{32}$	1 chance in 25.6

probability of these parents having three successive offspring who will be identical at both the ABO and Rh loci will be the product of the separate probabilities, or $\frac{1}{4} \times \frac{5}{32} = \frac{5}{128}$. It should be obvious that as more loci are added, the probability of having three successive offspring identical at all the loci will decrease. Table V presents the results of these computations for five sets of triplets (the parents of set No. 106 not being recorded), utilizing the seven blood group loci. Probabilities for two as well as three identical offspring are indicated.

TABLE V. ESTIMATED PROBABILITIES OF TWO AND THREE OFFSPRING IDENTICAL AT THE VARIOUS SEROLOGIC LOCI FOR PARENTS OF TRIPLETS

PARENTS	PROBABILITY OF TWO IDENTICAL OFFSPRING	PROBABILITY OF THREE IDENTICAL OFFSPRING
Set No. 103	0.0018 1 chance in 539	0.000007 1 chance in 143,165
Set No. 107	0.0037 1 chance in 270	0.000028 1 chance in 35,791
Set No. 108	0.0029 1 chance in 341	0.000019 1 chance in 52,428
Set No. 109	0.013 1 chance in 76	0.00024 1 chance in 4,194
Set No. 111	0.035 1 chance in 28	0.0015 1 chance in 655

Utilizing parents as well as the triplet members themselves, we learn more about the zygosity of our triplets than if we were to confine our analysis to the blood group systems of the triplets alone. We can now give zygosity ratings as follows, using the code mentioned in the section on method:

Triplet Set	*Zygosity Rating*	
103	4	Triovular
106	3 or 4	Monovular or triovular
107	1	Monovular (AB)
108	3	Monovular (AC)
109	5	Monovular
111	2 or 4	Monovular or triovular

The Taster Test.—We turn next to the results of the taste test for sensitivity to phenylcarbamide (PTC). These are given in Table VI, together with the indicated zygosity based on the taster test alone and the "actual" zygosity as determined by combining all tests. The ability to taste phenylthiocarbamide is generally thought to be inherited on the basis of simple Mendelian dominance. A homozygous recessive genotype will render the person unable to taste this substance. The correlation between genotype and phenotype is not 100 per cent, however,[48] so that the test is more adaptable to population genetics than to twin studies. As shown in Table VI, the results do not contradict the blood group findings in any instance; on the other hand, they provide no additional information. Those persons whom we accepted as monovular on the basis of probability are not discordant with regard to ability to taste PTC.

TABLE VI. RESULTS OF TASTE TEST FOR SENSITIVITY TO PHENYLTHIOUREA (PTC)

TRIPLET SET		SENSITIVITY	ZYGOSITY INDICATION	ACTUAL ZYGOSITY
	A	Taster		
No. 103	B	Taster	5	4
	C	Taster		
	A	Taster		
No. 106	B	Nontaster	3	3
	C	Taster		
	A	Nontaster		
No. 107	B	Nontaster	5	1
	C	Nontaster		
	A	Nontaster		
No. 108	B	Taster	3	3
	C	Nontaster		
	A	Taster		
No. 109	B	Taster	5	5
	C	Taster		
	A	Taster		
No. 111	B	Taster	5	4
	C	Taster		

Fingerprints.—Dermatoglyphics is widely recognized for its great value in identification procedures. It is not as generally known that it possesses great potentialities for biologic and anthropologic research. Fingerprints are completely established, except for size, during the first four or five months of embryonic and fetal development and are not affected by postnatal factors.[40] Although not infallible, dermatoglyphics has been used extensively in twin diagnosis. Diagnosis of monozygosity is made on the basis of high degree of similarity rather than identity. Bonnevie[5] and others have indicated that at least one pair of alleles is involved in the determination of the number of ridges. It is generally conceded that the total expression of fingerprints, in pattern and intensity, is dependent upon a large number of genes in several loci. Indeed, this may be a distinct advantage of dermatoglyphics over blood grouping and other techniques in population studies.[40] Studies by MacArthur[31] have shown that ridge counts have the highest heritability, followed by finger-tip patterns, palmar patterns, and palmar main lines.

TABLE VII. DERMATOGLYPHIC PATTERN TYPES (GALTON SYSTEM)

	TRIPLET SETS																					
	103				106				107				108				109				111			
FINGER	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*
Right hand																								
1	L	L	W	1	L	L	L	5	L	L	W	1	W	W	L	1	L	L	L	5	L	L	W	1
2	L	L	L	5	L	L	L	5	W	W	W	5	W	W	W	5	A	L	L	2	W	L	L	2
3	L	L	L	5	L	L	L	5	L	L	L	5	L	L	L	5	L	L	L	5	L	L	W	1
4	W	W	W	5	L	L	W	1	L	L	W	1	W	W	W	5	L	L	L	5	W	W	W	5
5	L	W	L	3	L	L	L	5	L	L	W	1	L	W	L	3	A	A	L	1	W	W	W	5
Left hand																								
1	L	W	L	3	L	L	L	5	L	L	L	5	W	W	L	1	L	L	L	5	L	W	L	3
2	W	W	L	1	L	A	L	3	L	L	W	1	W	W	W	5	A	L	L	2	W	L	L	2
3	L	L	L	5	L	L	L	5	L	L	L	5	L	L	W	1	A	A	A	5	L	L	L	5
4	W	L	W	3	L	L	L	5	L	L	W	1	W	W	W	5	L	L	L	5	W	L	W	3
5	L	W	W	2	L	L	L	5	L	L	L	5	W	W	W	5	L	L	A	1	L	W	W	2
Final diagnosis				4				5				1				1				5				4
Actual diagnosis (according to blood types)				4				3				1				3				5				4

*Diagnosis of zygosity based on similarity of types. Legend is same as for Table VI.

In Table VII the finger-tip pattern for each finger of each subject is recorded, together with an estimate of zygosity based upon over-all resemblance. In no case is there disagreement with the actual zygosity diagnosis, although the fingerprint patterns fail to indicate that only siblings A and C are monovular in sets No. 106 and No. 108. When fingerprint patterns are subdivided into numerous types (Table VIII), there seems to be less power to diagnose accurately or decisively.

TABLE VIII. DERMATOGLYPHIC PATTERN TYPES (MAIRS' CLASSIFICATION MODIFIED BY CUMMINS AND MIDLO

	TRIPLET SETS																					
	103				106				107				108				109				111			
FINGER	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*
Right hand																								
1	29	?	13	?	28	28	28	5	28	29	?	?	21	21	28	1	28	28	28	5	28	21	13	4
2	28	28	28	5	28	28	28	5	1	3	3	2	7	5	18	4	27	27	27	5	2	36	24	4
3	28	28	28	5	28	28	28	5	28	28	28	5	28	28	28	5	27	28	28	2	28	28	5	1
4	?	8	7	?	28	?	?	?	28	28	7	1	18	13	18	3	27	28	28	2	18	11	5	4
5	?	8	?	?	28	28	28	5	28	28	7	1	28	13	28	3	27	27	27	5	?	5	5	?
Left hand																								
2	7	?	24	?	24	39	24	3	28	28	28	5	7	2	18	4	27	27	28	1	9	27	15	4
3	24	24	24	5	24	24	24	5	24	24	24	5	24	24	18	1	27	39	39	2	24	18	24	3
4	1	9	2	4	24	24	?	?	?	24	2	?	18	18	5	1	24	?	24	?	18	27	9	4
5	?	9	2	?	24	24	?	?	?	?	?	?	18	?	18	?	?	?	?	?	18	?	?	?
Final diagnosis				5				3				5				1				5 or 2				4
Actual diagnosis (according to blood types)				4				5				1				3				5				4

*Diagnosis of zygosity based on similarity of types. Legend is same as for Table VI.
†Thumbprints of left hand were not satisfactory.

As predicted by MacArthur, ridge counts seem to be very powerful diagnostic tools. Table IX presents all counts that could be made. Some counts could not be made because of faulty technique in making the prints. It must be pointed

TABLE IX. DERMATOGLYPHIC RIDGE COUNTS

	TRIPLET SETS																							
	103				106				107				108				109				111			
FINGER	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*	A	B	C	D*
Right hand																								
			21								15													
1	20	13	10	4	20	13	20	3	20	15	?	4	20	15	20	3	18	10	16	3	23	16	23	3
									13		9		13	13							9			
2	9	4	12	4	14	6	12	3	11	20	20	?	8	16	12	4	0	0	0	5	15	3	9	4
																							12	
3	6	7	12	1	13	9	16	4	12	15	18	1	13	11	13	3	0	4	4	2	11	8	7	1
	9	12	15								16			15									15	
4	8	4	3	4	17	?	?	?	17	?	5	?	14	10	16	3	0	2	5	2	6	4	9	1
											20											13	13	
5	?	?	?	?	?	7	?	?	15	?	11	?	14	?	11	?	0	0	0	5	?	7	7	2
Left hand																								
1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	5												17	9									14	
2	3	?	9	?	10	?	13	?	17	18	17	5	8	11	13	4	0	0	4	1	8	0	6	4
3	7	6	11	1	20	17	16	2	10	11	15	1	9	15	15	2	0	0	0	5	11	4	9	3
	9	4	14								8				14								7	
4	9	8	12	4	?	?	?	?	?	16	19	?	11	14	10	1	7	?	3	?	6	0	11	4
		7	8																			9	5	
5	?	?	?	?	?	?	?	?	?	?	?	?	?	?	15	?	?	?	?	?	?	?	?	?
Final diagnosis				4				3				1				3				5				4
Actual diagnosis (according to blood types)				4				3				1				3				5				4

*Diagnosis of zygosity based on similarity of types. Legend is same as for Table VI.

TABLE X. CONCORDANCE (+) AND DISCORDANCE (-) IN ELEVEN MORPHOLOGIC TRAITS OF THE LOWER PREMOLARS (AFTER KRAUS AND FURR)

	TRIPLET SETS											
	103			107			108			109		
TRAIT NO.*	1	2	3	1	2	3	1	2	3	1	2	3
1	?	?	+	+	-	-	-	-	+	+	+	+
2	+	+	+	+	-	-	-	-	+	+	+	+
3	+	+	+	+	-	-	+	+	+	+	+	+
4	-	-	-	+	+	+	+	+	+	+	+	+
5	+	-	-	+	-	-	-	-	+	+	+	+
6	-	-	+	-	-	+	-	-	+	+	+	+
7	-	+	-	+	+	+	+	+	+	+	+	+
8	-	+	-	+	+	+	+	+	+	+	+	+
9	-	-	-	+	-	-	-	+	-	+	+	+
10	+	-	-	+	-	-	-	-	+	+	+	+
11	+	-	-	+	-	-	?	+	?	+	+	+
Total number of concordances	5	4	4	10	3	4	4	6	9	11	11	11
Frequency of concordances	.50	.40	.36	.91	.27	.36	.40	.54	.90	1.0	1.0	1.0
Zygosity indication		4			1			3			5	
Actual zygosity		4			1			3			5	

*Traits defined as follows:
1 = Number of external lingual grooves.
2 = Sagittal sulcus.
3 = Position of deuteroconid.
4 = Number of lingual cusps.
5 = Mesial protoconid margin.
6 = Mesial deuteroconid margin.
7 = Distal protoconid margin.
8 = Central occlusal protoconid ridge.
9 = Number of occlusal protoconid ridges.
10 = Deuteroconid-protoconid relationship.
11 = Size of protoconid ridge.
(See Kraus and Furr[25] for detailed description.)

out that zygosity diagnosis is ordinarily made on the basis of *total* ridge count on all ten fingers. We have made a comparison finger by finger. However, a total count gives exactly the same results. The diagnosis agrees with that obtained by the probability method using blood groupings and goes even farther. Whereas the blood-grouping technique was not definitive for sets No. 106 and No. 111, indicating that the former could be rated either 3 or 4 and the latter 2 or 4, the ridge counts indicate that in No. 106 siblings A and C are truly monovular while in No. 111 siblings A and B are not monovular. Thus, No. 111 is diagnosed by ridge counts as a triovular set. It is interesting to recall that the probability of A and B in set No. 111 being diovular was higher than for any other twin pair having identical blood groups.

Dental Morphology.—A new technique for diagnosing zygosity has been advanced by Kraus and Furr[25] and tested population-wise by Kraus.[23] It is based upon certain discrete structural characteristics of the lower first premolars. The method is therefore limited to persons over 10 years of age and, because of caries and excessive wear, under 25 or 30 years. It has been postulated that these morphologic traits are independently inherited but the mode of inheritance has not been established. Eleven of these traits were observed and recorded in four triplet sets (Table X). Concordance and discordance were noted between each of the possible pairings (1, 2, and 3) in each set. The concordances were then totaled for each pair and the relative frequency of concordances was recorded. In set No. 103 the concordance frequencies were 0.50, 0.40 and 0.36, indicating that there were as many (or more) discordances between each pair as there were concordances. The diagnosis is, therefore, triovularity. In set No. 107 there was 91 per cent concordance for pair A and B, but only 27 per cent and 36 per cent for pairs B and C and A and C, respectively. This is precisely the zygosity indicating by blood grouping and dermatoglyphics. Similarly, in sets No. 108 and No. 109, the zygosity is clearly indicated by the differential concordance frequencies. Unfortunately, the triplets in set No. 111 had not erupted their lower first premolars. It would seem, on basis of this small sample, that the lower first premolar examination ranks with dermatoglyphic ridge counts for positive diagnosis of monozygosity and with blood grouping for detecting dizygosity. Plates I and II illustrate many of the structures of the premolars and permit the reader to see for himself the unusual degree of concordance in monovular twins and triplets.

The well-known Carabelli tubercle or cusp of the maxillary first molar has been considered by most writers to be inherited according to simple Mendelian dominance.[22, 24, 42] Dietz[9] is led to believe that its genetic pattern is a complex one. Family studies have yet to be carried out to determine the mode of inheritance. Twin studies, however, indicate that the trait is under rather strict genetic control.[11, 23] In diagnosing zygosity, therefore, we must consider the Carabelli trait, like the lower first premolar traits, a second-order variable. Some authors have recognized several different manifestations of the Carabelli trait and have classified them in a variety of ways.[9, 44] The method employed by Kraus,[24] who calls the trait "Carabelli's anomaly," will be utilized here. Four aspects are recognized: (1) the pronounced tubercle, with a palpable apex; (2)

Plate I.

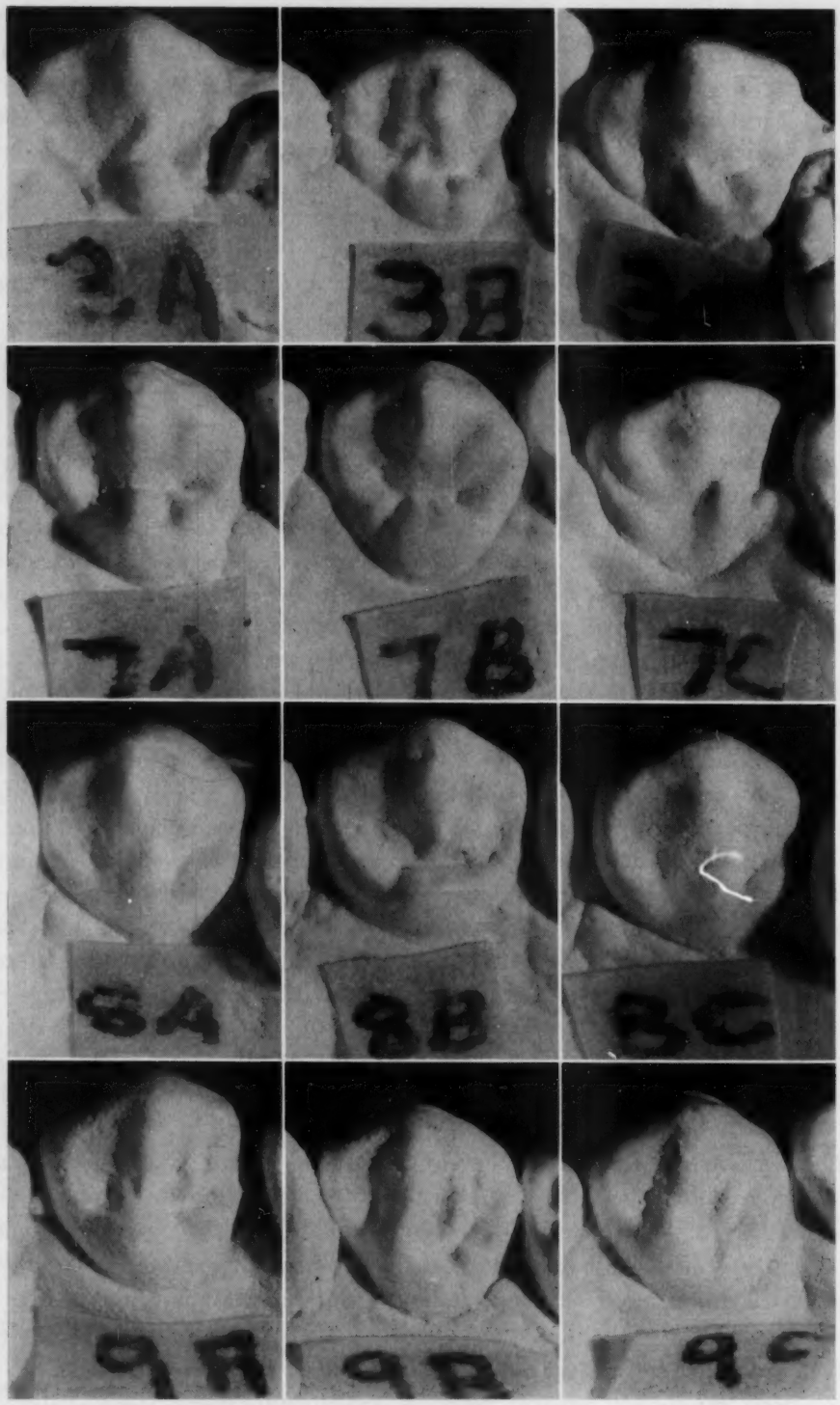


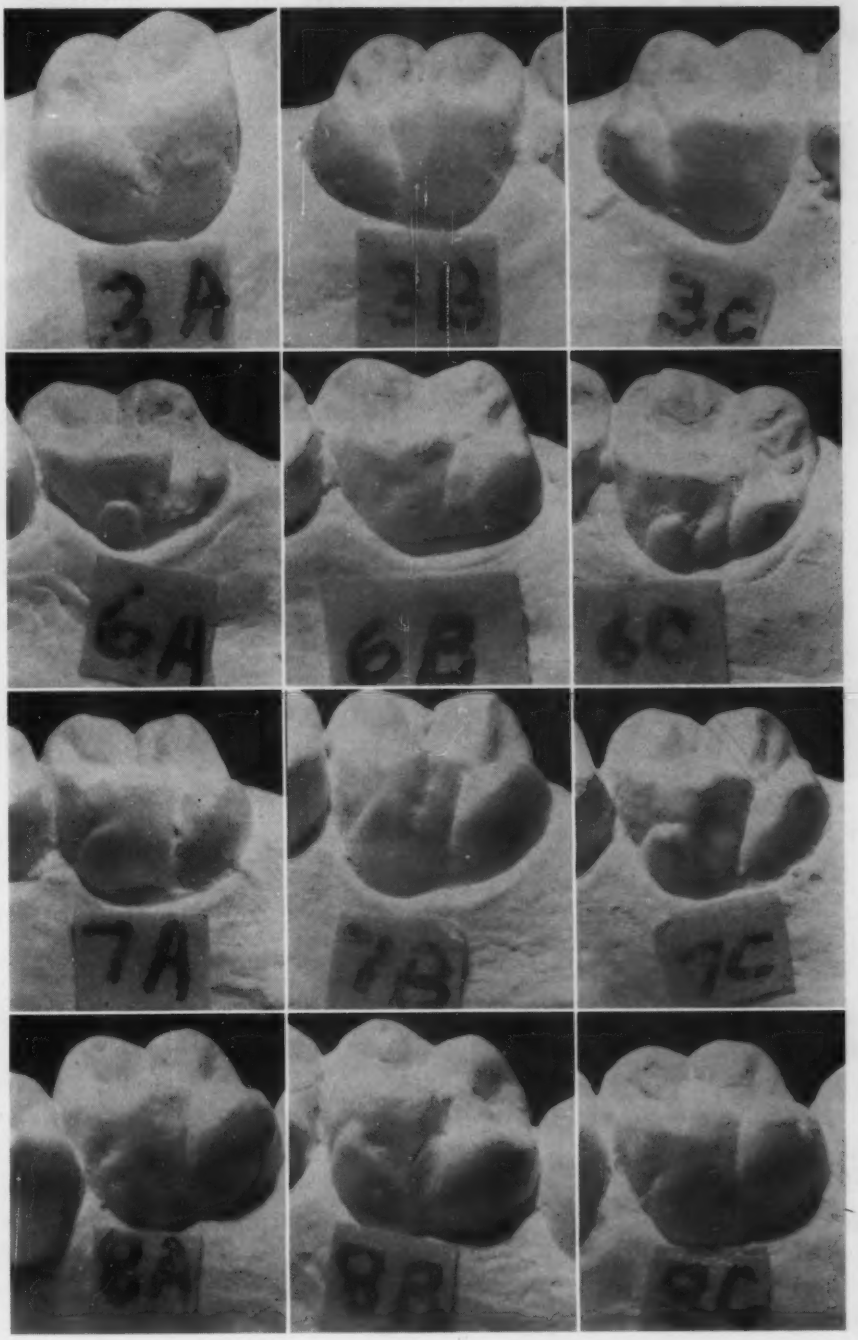
Plate II.

Plate I.—Lower right first premolars, illustrating inherited morphologic structures. *A*, Triplet set No. 103. *B*, Triplet set No. 107.

Plate II.—Lower right first premolars, illustrating inherited morphologic structures. *A*, Triplet set No. 108. *B*, Triplet set No. 109.

the slight tubercle, whose apex merges into the side of the mesiolingual cusp; (3) one or more pits or grooves at the site of the anomaly; and (4) complete absence of any manifestation.

Plate III.



A.

B.

A.

B.

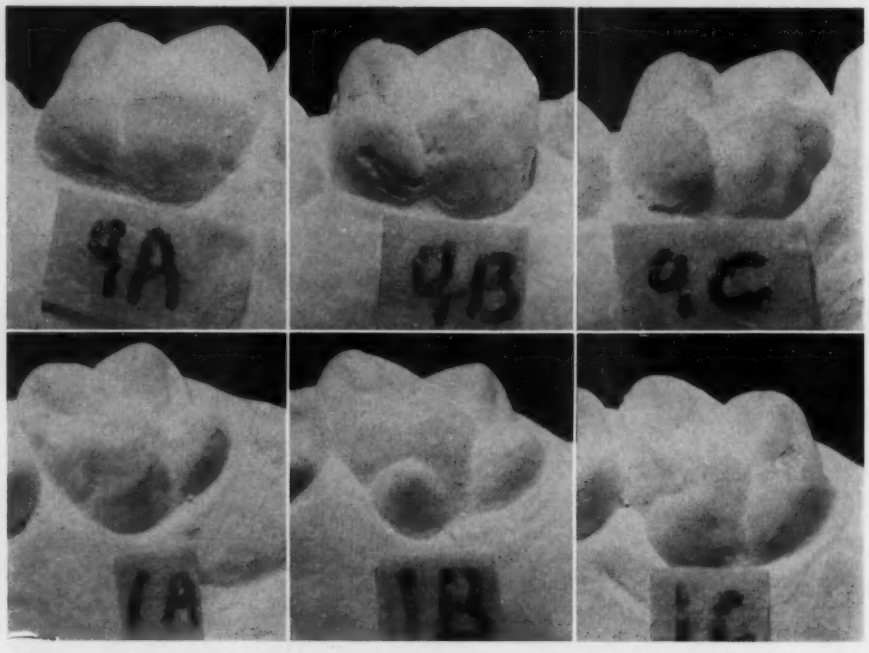
Plate IV.

Plate III.—Maxillary first molars, illustrating Carabelli's anomaly. *A*, Triplet set No. 103 (right molars). B, Triplet set No. 106 (left molars).

Plate IV.—Maxillary first molars, illustrating Carabelli's anomaly. *A*, Triplet set No. 107 (left molars). *B*, Triplet set No. 108 (left molars).

Plates III, IV, and V present photographs of the cast of the maxillary first molar for each triplet set. In set No. 103 A is differentiated from B and C in having a groove. The other two members of the set show an absence of the trait. In set No. 106 both A and C display pronounced tubercles of the same size, while B shows only a slight groove. In set No. 107 A and B have slight tubercles of about the same size and shape, but C has a pronounced tubercle.

A.



B.

Plate V.—Maxillary first molars, illustrating Carabelli's anomaly. *A*, Triplet set No. 109 (right molars). *B*, Triplet set No. 111 (left molars).

All three members of set No. 108 look similar, but careful scrutiny of the photographs shows that A and C possess a single groove each, while B has a slight tubercle. In set No. 109 the trait appears absent in A and B, with a very slight tubercle apparent on C. It should be pointed out the three teeth are not oriented in exactly the same way, so that a slightly different orientation will reveal that each person has a very slight bulge at the same site. In No. 111 the three siblings show clearly differentiated manifestations of the Carabelli anomaly. A has a groove, B has a pronounced tubercle, and C has a slight tubercle with a deep groove. On the basis of the Carabelli anomaly, set No. 111 is diagnosed as triovular. It is interesting to note that it was not possible to achieve this diagnosis on the basis of blood grouping and probability. On the other hand, the diagnosis of diovularity for B and C cannot be made on the basis of the Carabelli anomaly. Otherwise, the results are in accordance with those yielded by blood grouping, dermatoglyphics, and the lower first premolars.

Stature and Weight.—Stature and weight, which we may call third-order variables, have been recorded for each person, and an indicator of body build, the

height-weight index, has been computed. As expected, these observations have no reliability in zygosity diagnosis. In set No. 111, for example, A, B, and C are practically identical in weight, stature, and body build, although this set is triovular. The members of the monovular set, No. 109, on the other hand, show dissimilarities in weight and body build. These variables illustrate what we have pointed out earlier, namely, that traits which are really complexes of many elements are inadequate for estimating heritability, even though heredity certainly contributes to their formation.

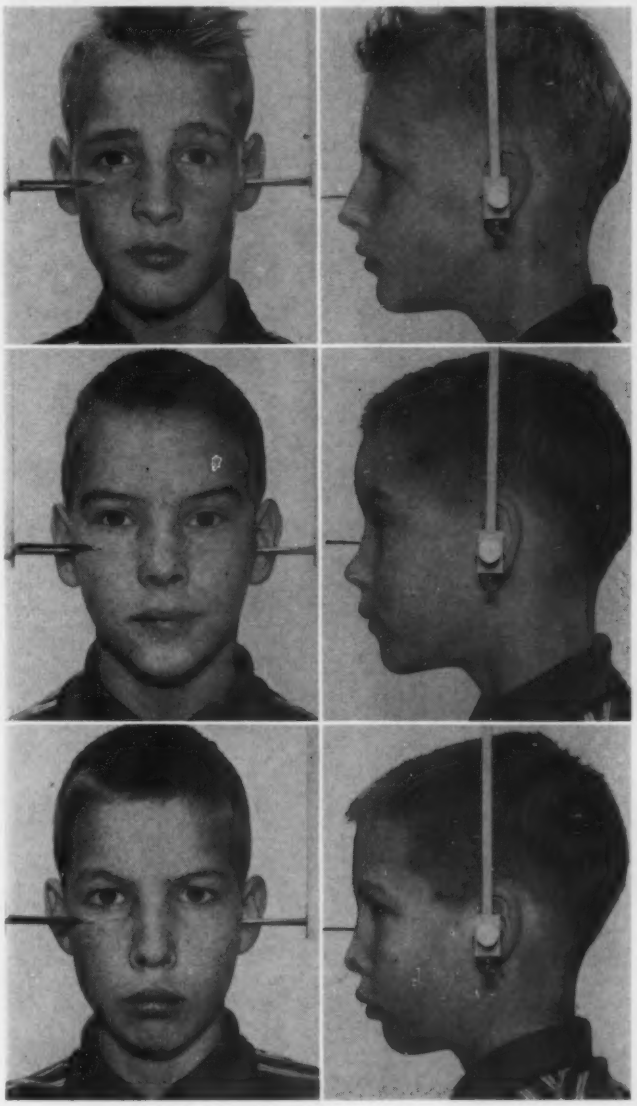


Plate VI.—Triplet set No. 103.

Photographs.—At this point the reader may be curious about the general appearance of the triplets. Having established the zygosity of each set with some assurance, one might wonder if the same results could have been achieved

simply by looking at the triplets and judging by the usual criteria of similarity. We permit the reader to do this for himself by scrutinizing Plates VI to XI, which provide frontal and lateral head views oriented in the Frankfort horizontal plane.

Plate VII.—Triplet set No. 106.

We have gone to rather unusual lengths in presenting our diagnosis of zygosity for the six triplet sets. Our purpose has been to underscore the difficulties involved in gaining greater diagnostic reliability and to cast suspicion upon the results of twin studies in which diagnosis has been based upon too hasty or too inadequate examination.

HERITABILITY IN THE CRANIOFACIAL COMPLEX

We have established, with a high degree of probability, the zygosity of each of the six triplet sets. The next order of business is to examine the craniofacial complex in order to determine whether it or any of its components can be demonstrated to be predominantly under hereditary control. It should be stated

Plate VIII.—Triplet set No. 107.

that this phase of the research was conducted independently, without previous knowledge of the zygosity of the triplets. In this way, bias was eliminated in making the many tracings.

The selection of traits is an important part of the methodology in such a problem. Each trait must be carefully defined and its biologic significance noted. We must remember, above all, that no matter what individual trait or complex

Plate IX.—Triplet set No. 108.

we choose to recognize, we really are being highly selective in that we consciously or unconsciously peel from it many attributes which make it a functioning part of a whole living organism. In selecting from a lateral headfilm a line, an angle, or a geometric configuration to follow through in our investigation of the influence of heredity, we must recognize that we are extracting an entity that has

no biologic individuality and no function. It is essentially a mental construct. If this be true, and we seem to observe some correlation between this trait and the genetic constitution, we are then faced with a serious problem of interpreta-

Plate X.—Triplet set No. 109.

tion. Is this trait controlled essentially by heredity? Or does this trait fortuitously reflect one or more biologic entities which are themselves the manifestations of genic action?

For example, the cephalic index is a time-honored ratio which has been employed by anthropologists in distinguishing the various prehistoric and

modern peoples of the world. It is simply the ratio of maximum breadth of the cranium to maximum length of the cranium measured from glabella to opisthocranion. It has many times been observed that certain populations are brachycephalic (round-headed, with a high cephalic index) and others are dolichocephalic (long-headed, with a low cephalic index). Since, in a general way, these populations breed true with respect to values of the index, it has

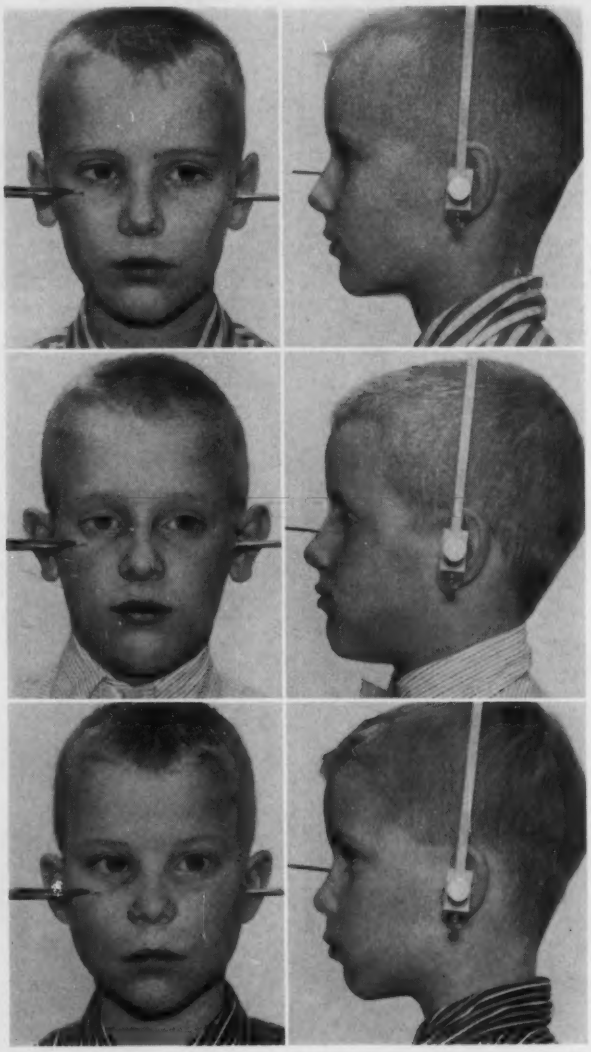


Plate XI.—Triplet set No. 111.

sometimes been said that this trait (the cephalic index) is inherited. Since length of the cranium is achieved during growth through the operation of many forces, elements, and their interactions, to say that the index is inherited or that "85 per cent of the trait" is inherited is really to say nothing at all! Certainly, we would predict that any attempts to establish the "genetic mechanism of inheritance" of the index would be doomed to failure or misinformation.

Let us begin with the craniofacial complex as a whole. A midsagittal profile of the cranium and certain structures of the facial skeleton drawn from a lateral headfilm is, of course, merely an arbitrary way of describing selected manifestations of the total complex in two dimensions. As with the cephalic index, the lateral profile is the result of the operation of many growth factors, only some of which are known. Since growth forces are under genetic control, we can safely say that the lateral head profile is influenced by heredity and environment. Can we learn whether heredity plays the predominant role? Is the lateral head profile a trait which is amenable to this sort of observation? In Fig. 1 lateral tracings of monovular triplets A and B of triplet set No. 107 are superimposed, with registry on *R* and holding the Bolton planes parallel. The over-all concordance of the two tracings is remarkable and might lead an incautious observer to assert that the lateral profile of the head is under rigid genetic control. When he then turns to Fig. 2 in which the tracings of diovular triplets A and C of set No. 107 are superimposed, his feelings will be reinforced. These triplets show greater discordance in all areas except the frontal and parietal profiles.

Now we examine similar tracings of another monovular pair, B and C of triplet set No. 109 (Fig. 3). The degree of discordance found here is greater than that expressed in pair A and B of set No. 107. We further note that there is no consistency in the areas of discordance. In triplets B and C of set No. 109 there is greater discordance in the lambdoidal and frontal areas, as well as in the malar and symphyseal regions. On the other hand, in Fig. 4 (triplets A and C of set No. 103) the tracings of diovular triplets show a much higher degree of concordance than do those of the monovular pair of set No. 109 and as great a concordance in general as those of monovular pair A and B of set No. 107.

In tracings of pairs taken from the other triplet sets, inconsistencies of the same type were observed. It is quite evident, then, that the craniofacial complex as represented by a lateral head profile is not amenable to heritability study by means of the twin method. We expect, and we observe, an over-all profile similarity in twins. Whether this similarity is meaningful in a hereditary sense can be determined only when it is compared with tracings of unrelated pairs of persons of the same sex, age, and general head size.

Since the lateral profile of the entire craniofacial complex is unsuitable for heritability studies by the twin method, we turn to a component of the complex, namely, a lateral profile of the cranial vault. In Plates XII, XIII, and XIV the lateral vault tracings of the three members of each triplet set are registered on *R* with Bolton planes drawn parallel. In Plate XII (the triovular set) there are very few points of contact from nasion to Bolton point. In Plate XIV (set No. 108) there is concordance between the monovular triplets A and C in the bregmatic and nuchal areas, and there is greater similarity throughout the rest of the perimeter as compared with their fraternal triplet B. On the other hand, let us examine diovular pair A and B of set No. 103 (Plate XII). As high a

Fig. 1.

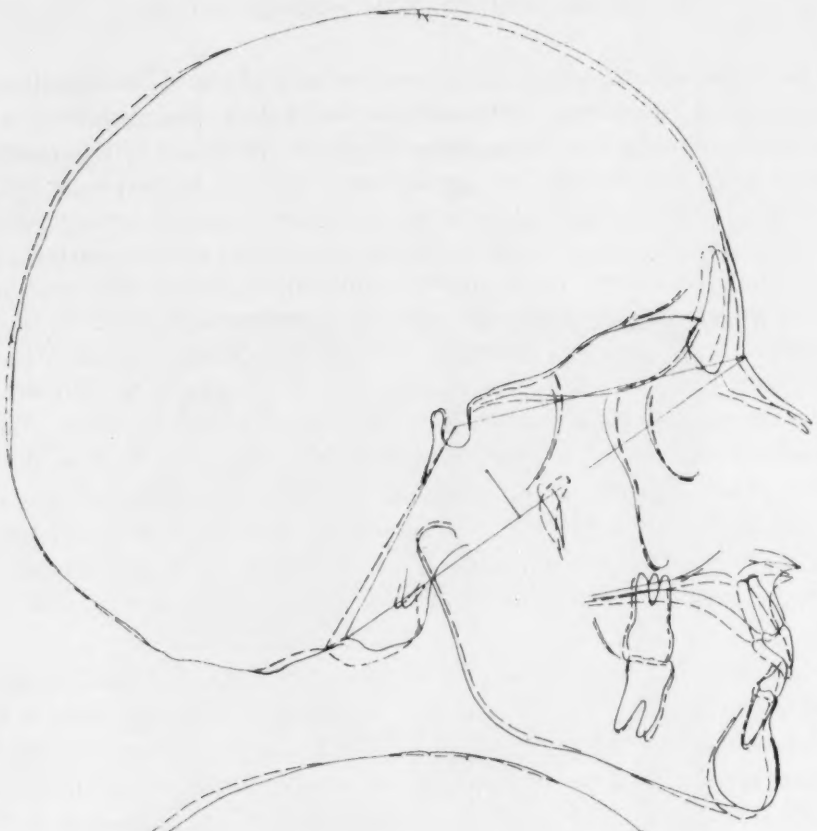


Fig. 2.

Fig. 1.—Superimposing of lateral tracings of monovular twins (107 AB) registering on *R* with Bolton planes parallel.

Fig. 2.—Superimposing of lateral tracings of diovular twins (107 AC) registering on *R* with Bolton planes parallel.

Fig. 3.

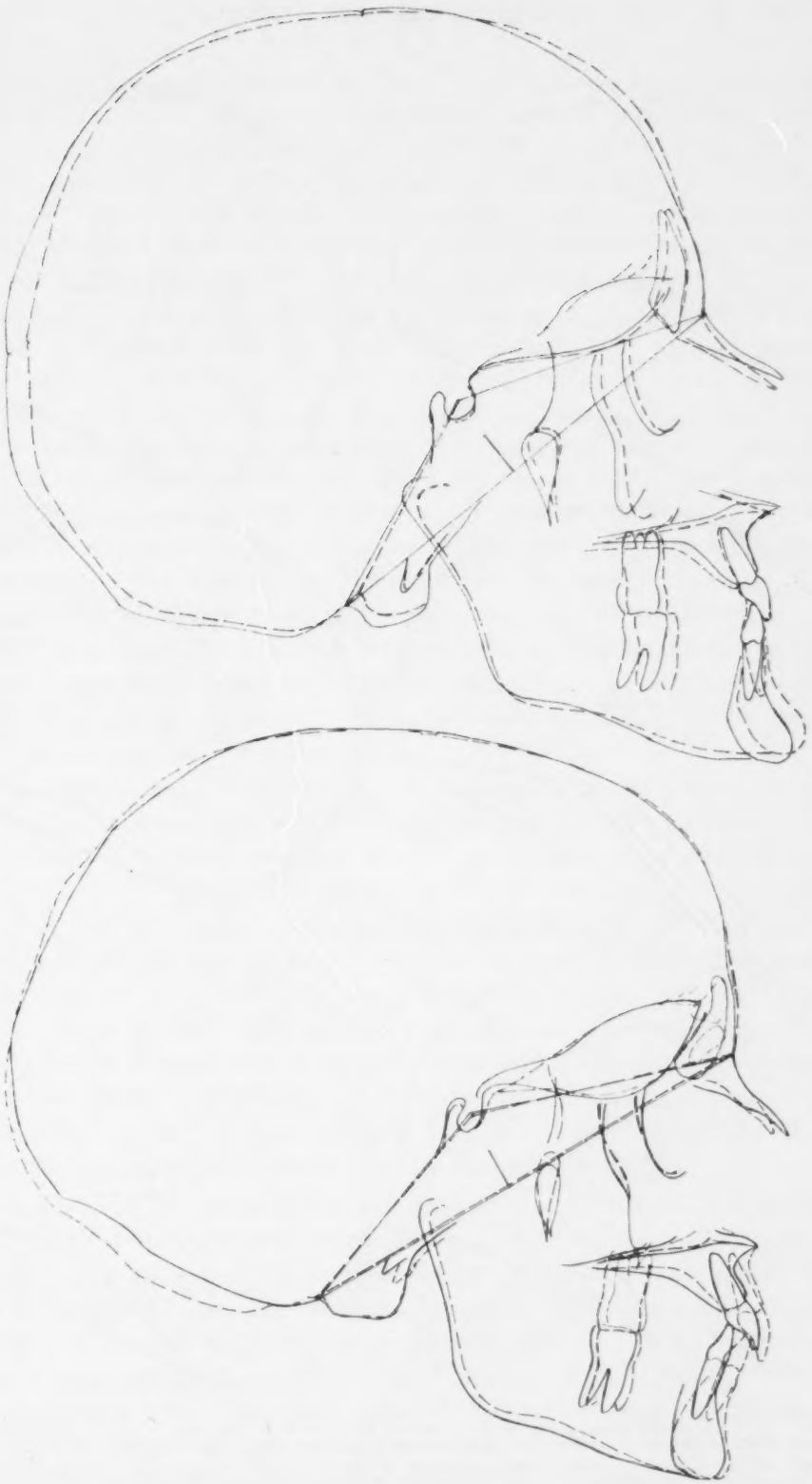


Fig. 4.

Fig. 3.—Superimposing of lateral tracings of monovular twins (109 BC) registering on *R* with Bolton planes parallel.

Fig. 4.—Superimposing of lateral tracings of diovular twins (103 AC) registering on *R* with Bolton planes parallel.

Plate XII.

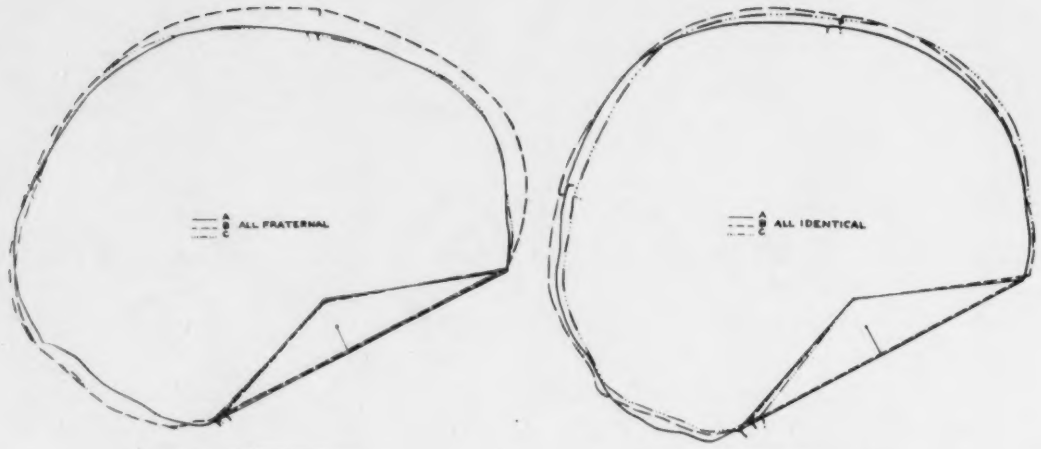


Plate XIII.

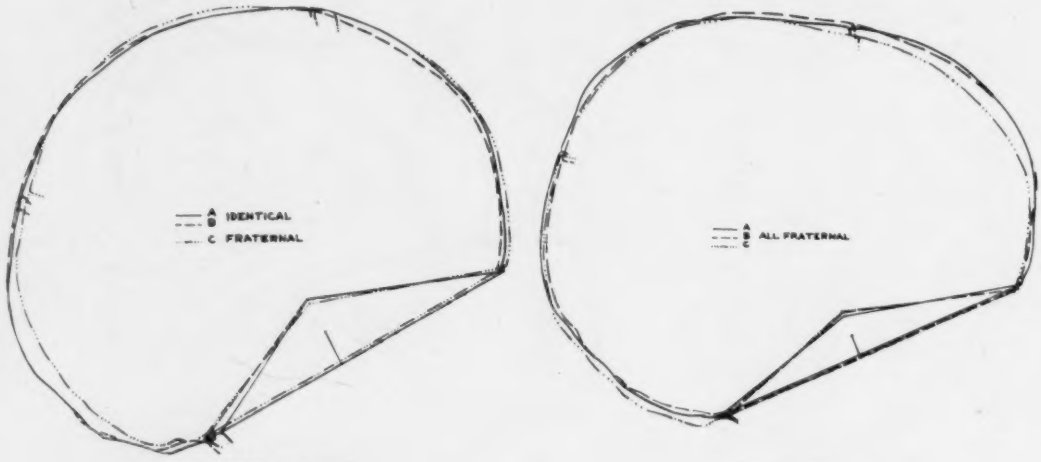


Plate XIV.

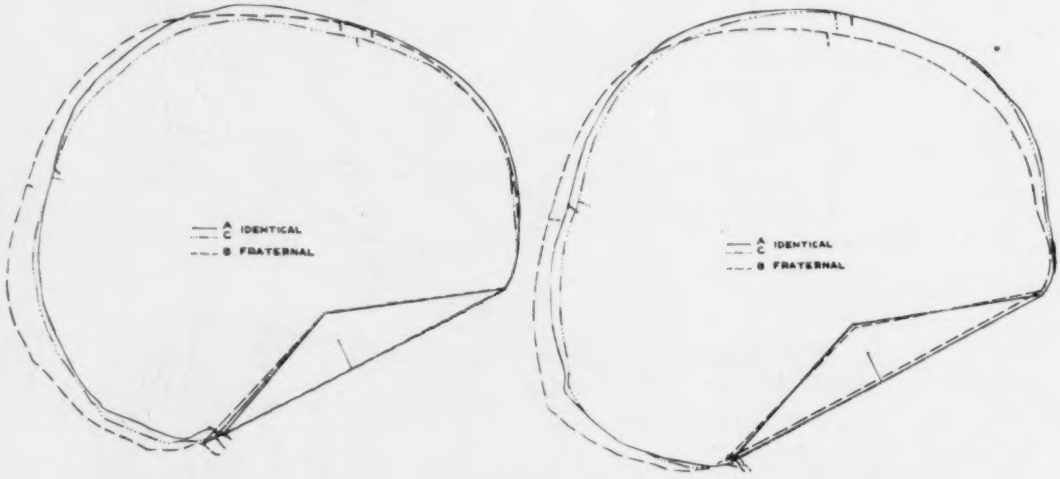


Plate XII.—Lateral cranial vault tracings of triplets No. 103 and No. 109, superimposing on *R* with Bolton planes parallel. *A*, Triplet set No. 103. *B*, Triplet set No. 109.

Plate XIII.—Lateral cranial vault tracings of triplets No. 107 and No. 111, superimposing on *R* with Bolton planes parallel. *A*, Triplet set No. 107. *B*, Triplet set No. 111.

Plate XIV.—Lateral cranial vault tracings of triplets No. 106 and No. 108, superimposing on *R* with Bolton planes parallel. *A*, Triplet set No. 106. *B*, Triplet set No. 108.

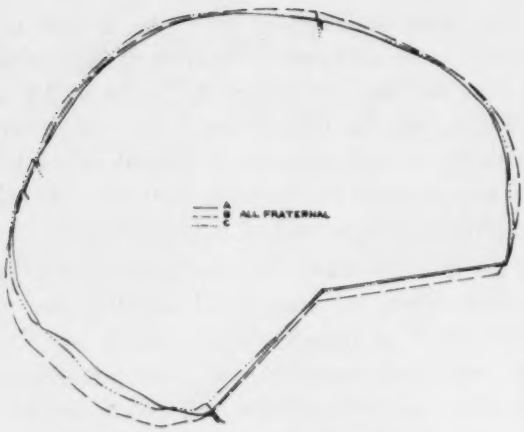
degree of concordance is found in these tracings as is to be found in any monovular pair, and a greater degree of concordance is evident than is exhibited by the monovular pairings A and C of set No. 108 (Plate XIV), A and C of set No. 106 (Plate XIV), or A, B, and C, of set No. 109 (Plate XII). If we were to attempt to judge zygosity on the basis of concordance of lateral cranial vault tracings registered on *R*, then we would have to conclude that No. 111 (Plate XIII) was a monovular triplet set, whereas in actuality it is triovular!

Another method of orienting the cranial vault is illustrated in Plates XV to XVII. In these tracings the sella-nasion lines are held parallel, and maximum profile contact is sought. It is readily apparent that triplet set No. 111, a triovular set, shows the greatest degree of concordance. The monovular set, No. 109, reveals considerable discordance in the posterior segment of the profiles. Triplets A and C in set No. 106 are remarkably similar throughout, but it should be noted that this concordance is achieved by a considerable inferior displacement of the sella-nasion plane and anterior displacement of the sella-articulare line. Siblings A and C in set No. 108 are clearly the more similar pair, B showing significant differences in the entire profile from nasion to articulare. In set No. 107 A and B are almost identical except for a small area anterior to bregma. The cranial base lines in this pair are also very similar. In the triovular set, No. 103, the situation can be summed up as generally equal discordance displayed by each of the three possible pairs.

Our conclusion at this point is that registration on *R* throws the cranial vault profiles into positions which tend to obscure the fact that there is a good deal of similarity in triplets in general. Furthermore, it is valueless in pointing out whether or not monovular persons have more similar cranial profiles than diovular or triovular persons. On the other hand, by attempting to superimpose cranial vault profiles, we see immediately the essential likeness of these triplets and in some instances can note the greater concordance between monovular persons. However, this observation is gained at the expense of superimposing the sella-nasion planes. The latter are displaced in unpredictable ways. The cranial base, then, is not highly correlated, from the point of view of lateral profiles, with the cranial vault outline. This could have been predicted with a little reflection upon the differential growth processes involved.[45]

We next test the facial complex itself, utilizing a polygon that is identical or similar to those frequently employed in growth studies and in clinical assessment. The method of construction of the polygon is illustrated in Fig. 5, *A*. Four additional lines are drawn as indicated. It is perhaps unnecessary to elaborate on the fact that this facial polygon, and all similar ones, are more profound abstractions than is the lateral tracing of the cranial profile. For example, sella is a point in space. The line nasion-pogonion is partly in space, goes partly through teeth, and crosses random portions of discrete bones as well as areas where only soft tissue occurs. If this line is not a hereditary unit, how much less so is the entire polygon! It must be remembered that the utility of facial polygons for clinical evaluations in treatment and in growth is not under

Plate XV.



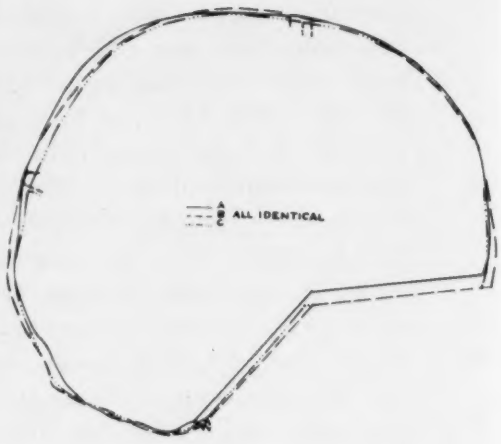
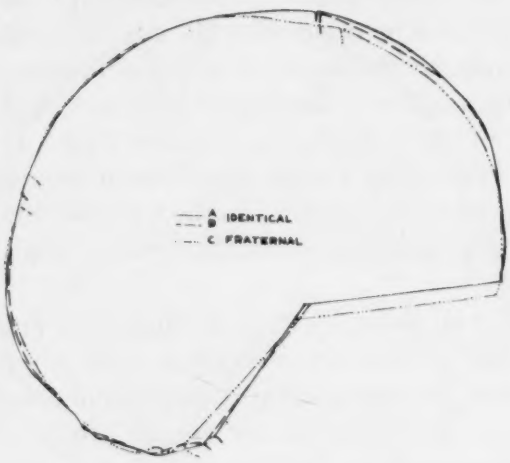


Plate XVI.



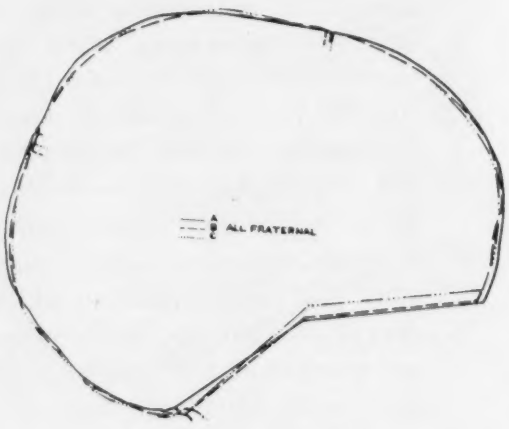
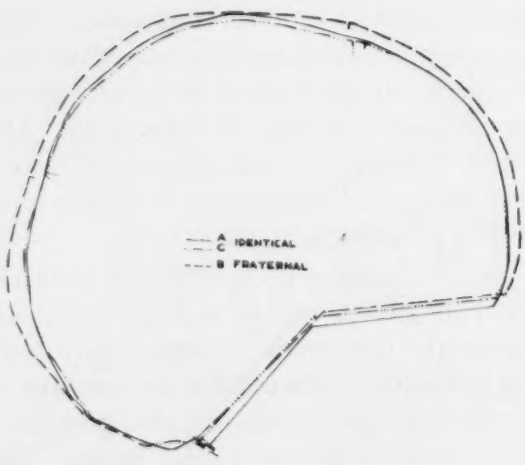
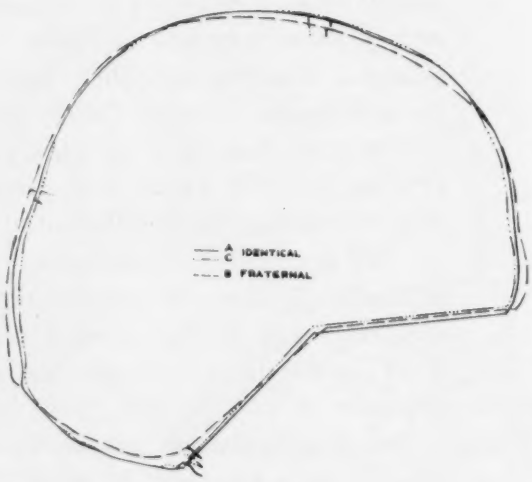


Plate XVII.





A. *B.*

Plate XV.—Lateral cranial vault tracings of triplets No. 103 and No. 109, superimposing on maximum contact with S-N planes parallel. *A*, Triplet set No. 103. *B*, Triplet set No. 109.

Plate XVI.—Lateral cranial vault tracings of triplets No. 107 and No. 111, superimposing on maximum contact with S-N planes parallel. *A*, Triplet set No. 107. *B*, Triplet set No. 111.

Plate XVII.—Lateral cranial vault tracings of triplets No. 106 and No. 108, superimposing on maximum contact with S-N planes parallel. *A*, Triplet set No. 106. *B*, Triplet set No. 108.

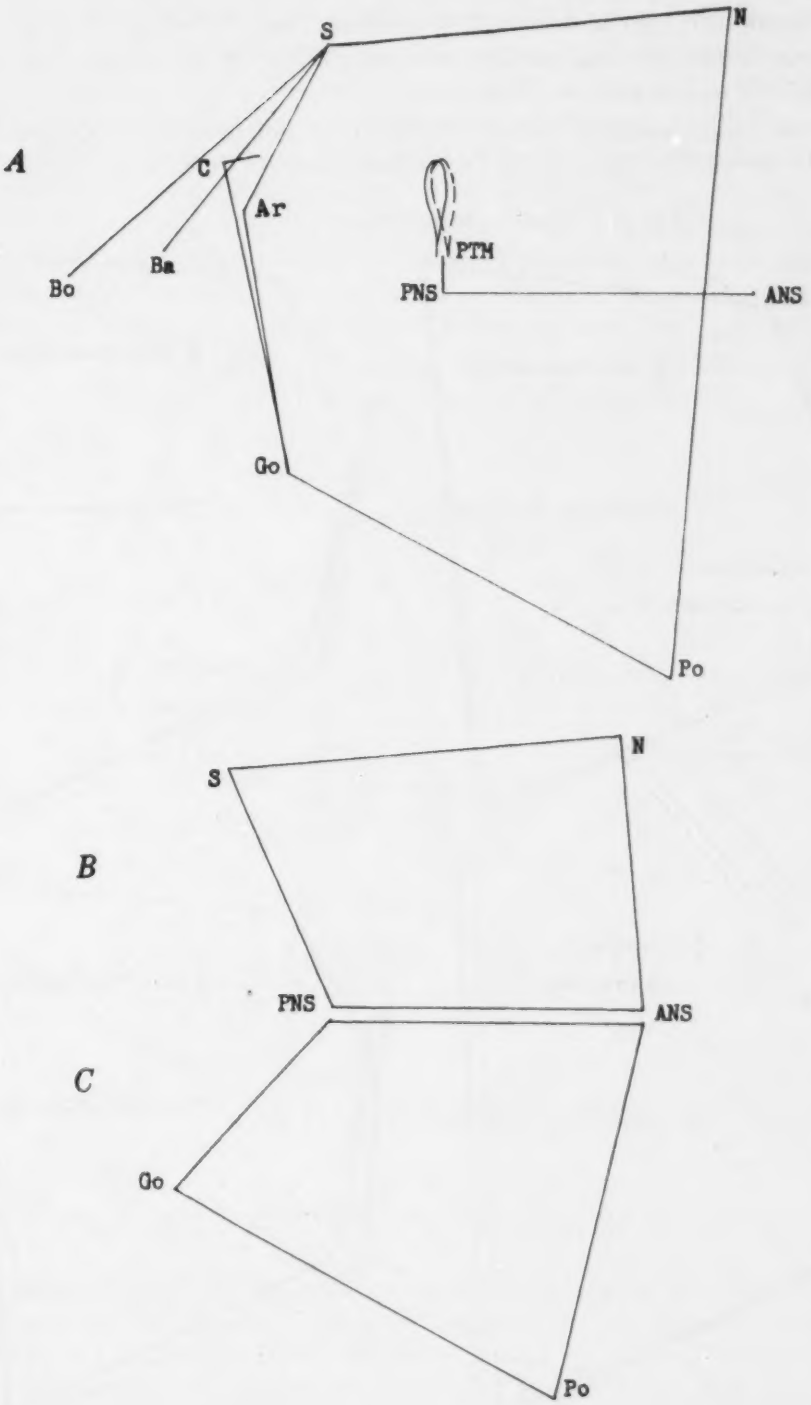
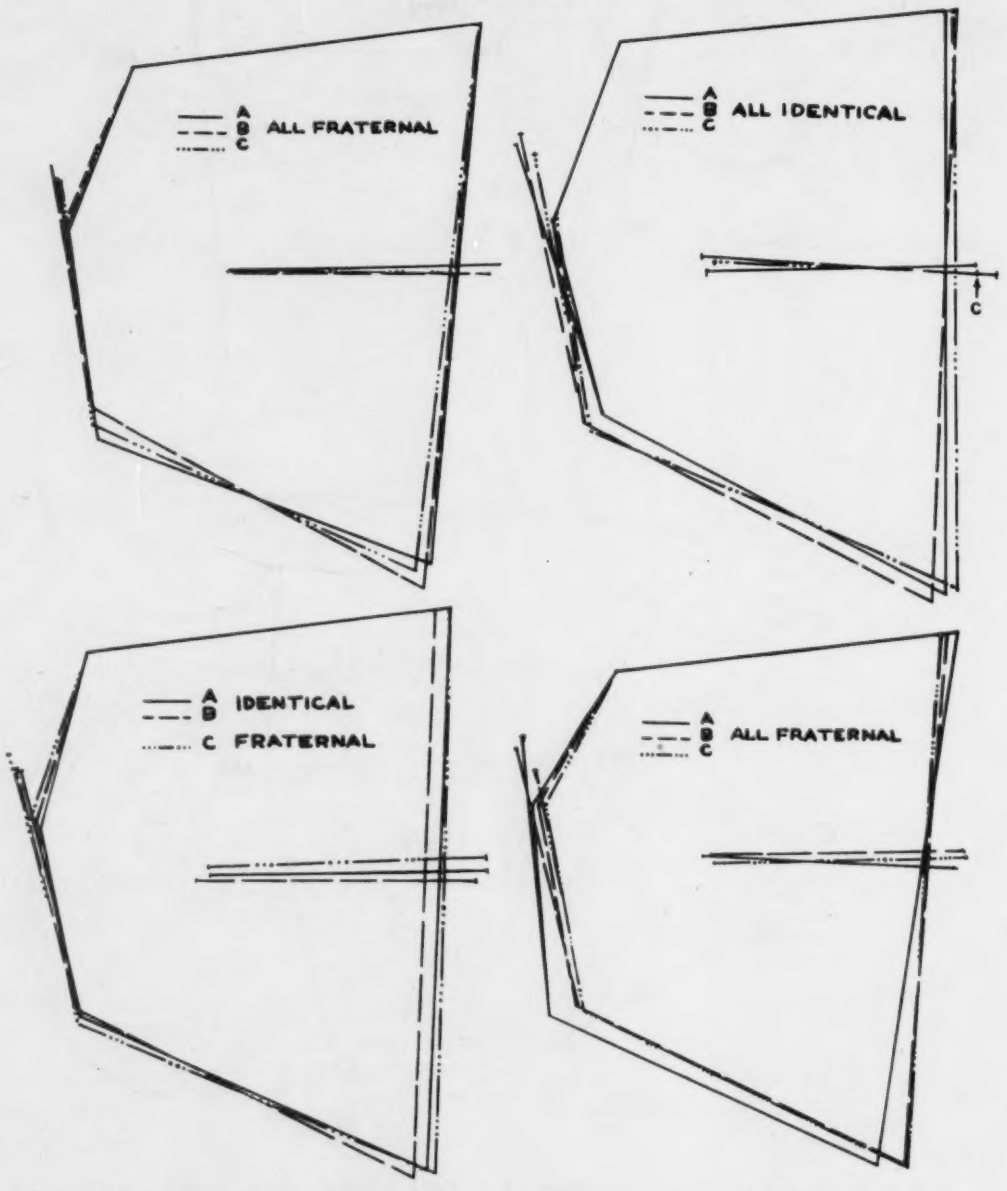


Fig. 5, *A*, *B*, and *C*.—Facial polygons. *S* = Sella turcica. *N* = Nasion. *ANS* = Anterior nasal spine. *Po* = Pogonion. *Go* = Gonion. *Ar* = Articulare. *PTM* = Pterygomaxillary fissure. *PNS* = Posterior nasal spine. *Ba* = Basion. *Bo* = Bolton point. *C* = Condylar apex.

question. Their applicability to heredity studies is the point under consideration. Again, our method has been to compare the polygon tracings of each set of triplets, superimposing on the sella-nasion line with registration on sella. Plates XVIII to XX present the results.

If the facial complex as manifested by a polygon is predominantly controlled by hereditary factors, then we expect identity or close similarity between

Plate XVIII.



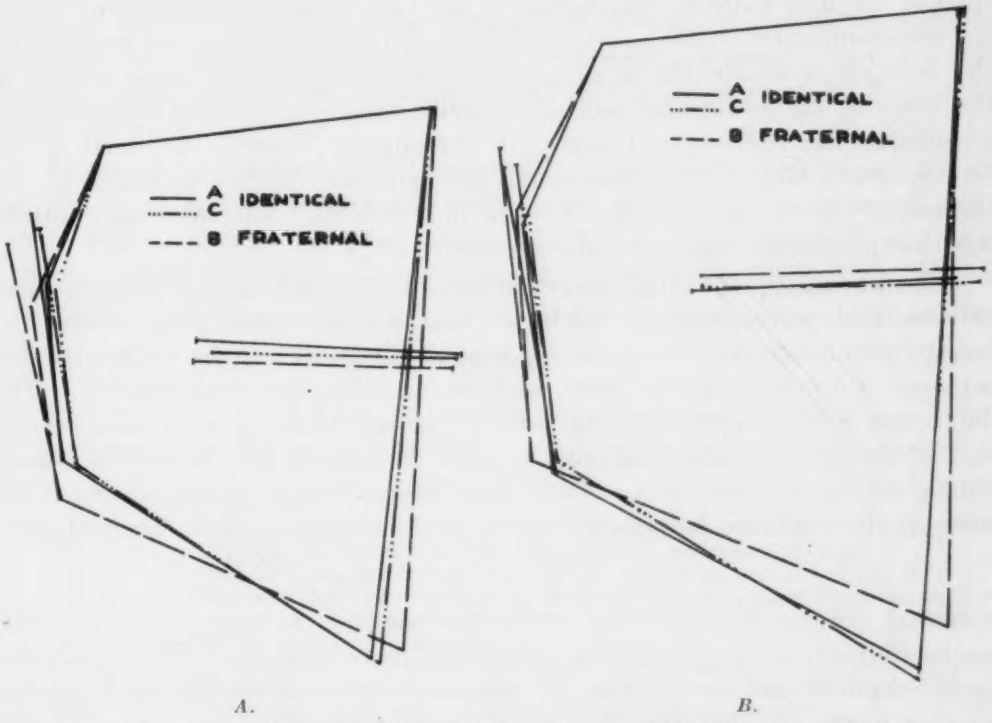
A. *B.*

Plate XIX.

Plate XVIII.—Facial polygons of triplets No. 103 and No. 109, superimposing on S-N with *S* registered. *A*, Triplet set No. 103. *B*, Triplet set No. 109.

Plate XIX.—Facial polygons of triplets No. 107 and No. 111, superimposing on S-N with *S* registered. *A*, Triplet set No. 107. *B*, Triplet set No. 111.

polygons of monovular triplets and less similarity between those of diovular triplets. Let us begin with set No. 109 (Plate XVIII). We are struck by the fact that all three sella-articulare lines superimpose; hence the three N-S-A angles are identical. From this point on, there is no longer identity in either lines or angles. Since the three S-N lines are of different lengths, as are the N-Po lines, the superimposing of the S-N-Po angles is strictly a matter of chance, or rather of geometric coincidence, and not of heredity. Thus, if lines A-S and S-N are of identical lengths in the triplet set and angle A-S-N is identical as well, but angle S-N-Po differs in each of the three triplets, then the remaining lines and angles will not superimpose. In other words, in a polygon of this nature we are dealing with a network of highly dependent variables and with a very few degrees of freedom. Vary one element and the interrelationships of many others are altered in, as Wylie[53] has observed, unpredictable ways.



A. *B.*

Plate XX.—Facial polygons of triplets No. 106 and No. 108, superimposing on S-N with *S* registered. *A*, Triplet set No. 106. *B*, Triplet set No. 108.

The least amount of discordance is observed, strangely enough, in the triovular set No. 103 (Plate XVIII). In addition to S-N, lines S-A and A-Go superimpose almost 100 per cent. However, line A-Go is of different length in each polygon; hence, angles A-Go-Po, Go-Po-N, and Go-N-S are discordant for the whole triplet set. The polygon comparison of the other triplet sets yields no reliable or objective data for discriminating monovular triplets. In fact, in triovular set No. 111 the degree of concordance between B and C is greater than that between any monovular pair. It will be recalled that these two persons had identical blood groupings and showed great physical resemblance (Plate XI).

Up to this point we have examined the craniofacial complex as a whole and then divided it into its two component parts—the cranial vault and the facial complex. We have demonstrated that none of these three complexes, as defined in lateral headfilm tracings, are amenable to the study of heritability by the twin method of analysis. Let us now turn our attention to smaller units of the facial complex. These are illustrated in Fig. 5, *B* and *C*. One may be termed an upper facial quadrilateral defined by points S, N, ANS, and PNS (Fig. 5, *A*). The other includes denture and mandible and might be labeled the maxillo-mandibular quadrilateral. It is defined by the points PNS, ANS, Go, and Po. The two quadrilaterals together comprise a major portion of the facial polygon.

We shall vary our method of analysis and approach the problem from the statistical aspect. If it is assumed that each of the four sides of either quadrilateral is an independent variable, that is, independently inherited, then it is expected that the difference between similar sides should be less in monovular than in diovular triplets. We hasten to say that there is no genetic warranty for this assumption. We merely exercise a license which may be justified by the end. It is reasonable to suppose that in a few isolated cases chance in the form of environmental whimsies might produce a greater difference in monovular than in diovular triplets. In the long run, however, the truth would be apparent, namely, that monovular are more similar in the length of the lines of the quadrilaterals than are diovular triplets. The same assumptions would apply to the four angles of each quadrilateral.

The statistical procedure was as follows: There were six possible monovular pairings and twelve diovular pairings. In the upper facial quadrilateral the lengths of the four sides were measured at random with respect to the eighteen persons. Correction scales[1] were used on all diameter measurements. The differences between corresponding sides of the quadrilateral were recorded for each of the eighteen pairs. In order to make each of the four sets of differences comparable to each other and additive, they were expressed as proportions of the mean of the combined lengths, according to the formula $\frac{a-b}{\frac{(a+b)}{2}}$. The four proportional differences were then totaled for each of the eighteen pairs. The means of these sums for the six monovular pairs and twelve diovular pairs were computed and the "t" test for unpaired data was applied to determine whether or not the difference between the means was significant. The formula $\frac{\bar{x}_1-\bar{x}_2}{s(\bar{x}_1-\bar{x}_2)}$, using pooled variances, was applied. Under the null hypothesis, we expect to find no real difference between means; in other words, the two groups would be samples drawn from the same universe. The results may be tabulated as follows:

		Mean	*t value*	*P*
Upper facial quadrilateral				
Lines	Monovular pairs	0.150	—	0.50
	Diovular pairs	0.144		
Angles	Monovular pairs	0.127	0.333	0.70
	Diovular pairs	0.117		

Maxillomandibular quadrilateral

Lines	Monovular pairs	0.179	0.66	0.40
	Diovular pairs	0.211		
Angles	Monovular pairs	0.124	1.06	0.30
	Diovular pairs	0.169		

In none of the four comparisons is the null hypothesis overthrown. The conclusion is obvious. Neither angles nor diameters of the upper facial or maxillomandibular quadrilaterals are able to express the differential influence of heredity over environment. Angles and diameters, like cranial and facial profiles, are not units of inheritance but are, rather, constructs which cut across, in random ways, the phenotypic manifestations of complex growth and functional forces operating in the head from prenatal life to moment of observation.

Apparently some of the traditional types of cephalometric concepts and techniques are not applicable to the study of heritability. Whether we use an approach that embraces the entire craniofacial complex or one that subdivides the complex into smaller components, the results are the same. None is a real biologic entity. None reflects the operation of a single genetically dominated system of development.

Using the techniques of roentgenographic cephalometry, and staying within its limitations, can we find smaller units of the craniofacial complex which fit our biologic demands and hence might allow us to learn if, where, and how heredity exercises a major measure of control in the craniofacial complex?

Except in certain cases, the usual lateral headfilm permits one to draw with a high degree of reliability the profiles of many skeletal structures. Other

TABLE XI. KEY TO BONE TRAITS

TRAIT NO.	DESCRIPTION
	From Lateral Headfilms
1	External surface of occipital bone, from Bolton point to lambda, in MSP
2	External surface of calvarium, from lambda to bregma, in MSP
3	Profile of external surface of squamous portion of frontal bone, in MSP
4	External profile of supraorbital portion of frontal bone from nasion to a point above the supraorbital ridge, in MSP
5	Profile of nasal bones in MSP
6	Profile of cerebral face of orbital portion of frontal bone in MSP
7	Profile of cerebral surface of cribriform plates of ethmoid bone in MSP
8	Profile of dorsum sellae and planum sphenoideum in MSP
9	Profile of sella turcica in MSP
10	Profile of frontal process of zygomatic bone defined by orbital margin and anterior margin of temporal fossa, in MSP
11	Profile of anterior portion of maxillary alveolus and nasal surface of palatine process of maxillary bone, in MSP
12	Profile of oral surface of palatine process of maxillary bone, in MSP
13	Profile of inferior border of mandible, from gonion to menton, in MSP
14	Profile of posterior border of ramus of mandible, from apex of condyle to gonion, in MSP
15	Profile of the posterior margin of the mandibular symphysis, in MSP
16	Profile of the anterior margin of the mandibular symphysis, in MSP
	From Frontal Headfilms
17	Profile of mandible from a point on the right posterior border of the ramus intersected by the mastoid process to the equivalent point on the left side

structures cannot be observed at all or, at best, can be drawn only in a speculative way. We found that there were at least 17 continuous-line outlines or profiles of individual bone segments that could be drawn accurately. By this, we mean that different observers can make tracings of these particular profiles which superimpose. The seventeen traits have been defined in Table XI and illustrated

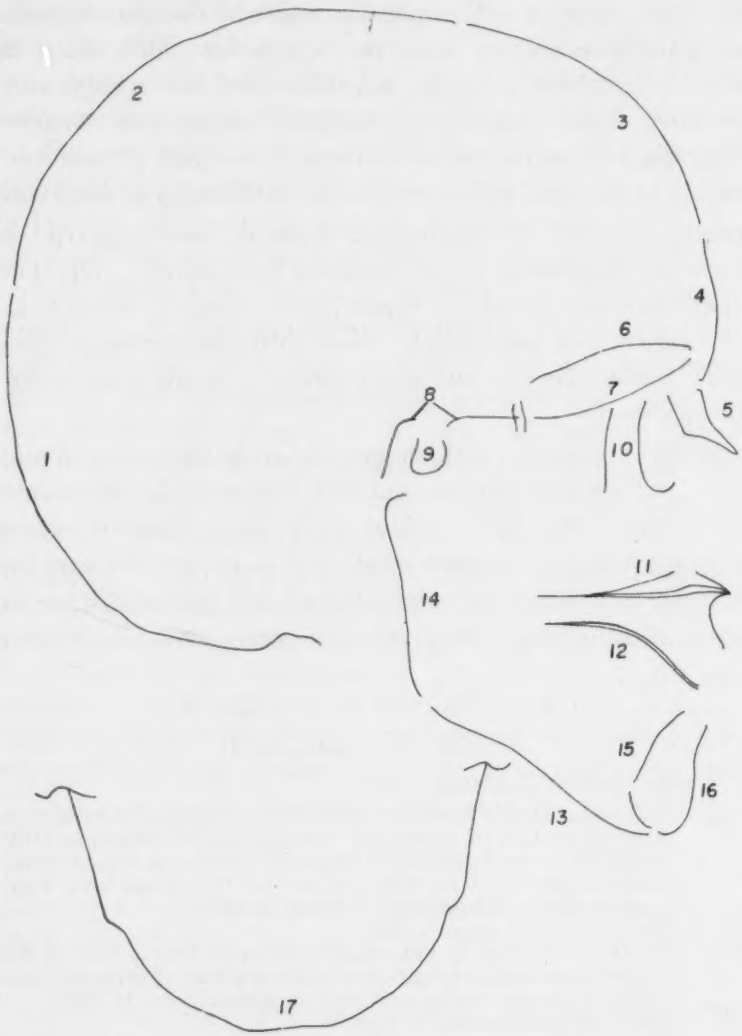


Fig. 6.—Identification of individual bone traits. (For key, see Table XI.)

graphically in Fig. 6. One is traced from a frontal headfilm and the other sixteen from lateral headfilms. It will be observed that each expresses the morphology of one or more aspects of a single bone as observed in two dimensions on a headfilm. These "traits," as we call them, can be called constructs only in the sense that any morphologic characteristic which is observed or measured is not descriptive of the entire structure. Each trait describes an aspect of the form of a single structural unit which is the expression of a definable system of

growth. We do not mean to imply that the control of any one of these structures is a simple genetic one or that environment plays no role. This would be naive, as we have stated several times previously. On the other hand, because a single system seems plausible in the development of each trait, we might hope that the genetic influence in this system might be discerned if predominant.

There being eighteen possible pairings of the six triplet sets, tracings of each of the seventeen traits were compared for each pair and maximum superimposition was attempted. Again, a source of bias was eliminated by having made these tracings before zygosity of the triplets was established. Examples of the results of this test are presented in Fig. 7. The number under each pair of tracings indicates the trait, the letter "a" indicates the comparison of a monovular pair, and the letter "b" designates the comparison of a diovular pair. There was no selection of pairs otherwise. In each of the illustrations A and C of set No. 106 represent the monovular pair and B and C of set No. 107 represent the diovular pair. As can be observed in Fig. 7, concordance is indicated only when the tracings are so similar that the smudge of the tracing pencil could have accounted for the difference. Discordance is anything more disparate than this. On the basis of this criterion, a check list of concordances and disordances was prepared for each of the seventeen traits for all eighteen pairs. The results are presented in Table XII. The number of concordances is totaled for each pair and then expressed as a proportion of the total number of traits.

TABLE XII. CONCORDANCE (+) AND DISCORDANCE (−) IN INDIVIDUAL BONE TRAITS

	TRIPLET SET																	
	103			106			107			108			109			111		
TRAIT NO.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	−	+	−	−	−	+	+	−	−	−	−	+	+	−	−	+	+	+
2	+	−	−	−	−	+	+	−	−	+	+	+	−	−	+	−	+	−
3	−	−	+	−	−	+	+	+	+	+	+	+	+	−	−	−	+	−
4	−	−	−	+	+	+	+	+	+	−	−	+	+	+	+	−	−	+
5	−	−	−	−	−	+	+	−	−	−	−	−	+	+	+	−	+	−
6	−	−	+	+	+	+	+	+	+	−	+	−	+	+	+	+	+	+
7	−	−	+	+	+	+	+	−	−	−	−	+	+	+	+	+	+	+
8	−	−	−	−	−	−	+	−	−	−	−	+	+	+	+	−	−	−
9	−	−	−	−	−	+	+	−	−	−	−	+	+	+	+	−	+	−
10	−	−	+	−	−	+	+	−	−	−	−	+	+	+	+	−	−	+
11	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−	−	−
12	−	+	−	+	+	+	+	−	−	+	+	+	+	+	+	−	−	−
13	−	−	−	−	−	+	+	−	−	−	−	−	+	+	+	+	−	−
14	−	+	−	+	+	+	+	−	−	+	+	+	+	+	+	−	−	+
15	−	−	−	−	−	−	+	−	−	−	−	−	+	+	+	+	−	−
16	−	+	−	+	+	+	+	−	−	−	−	+	+	+	+	−	+	−
17	−	−	−	−	−	+	+	−	−	−	−	+	+	+	+	−	+	−
Total number of concordances	1	4	4	7	7	15	17	3	3	4	5	13	16	14	15	5	9	6
Frequency of concordances	0.06	0.23	0.23	0.41	0.41	0.88	1.00	0.18	0.18	0.23	0.29	0.76	0.94	0.82	0.88	0.29	0.47	0.35
Zygosity indication		4			3			1			3			5			4	
Actual zygosity		4			3			1			3			5			4	

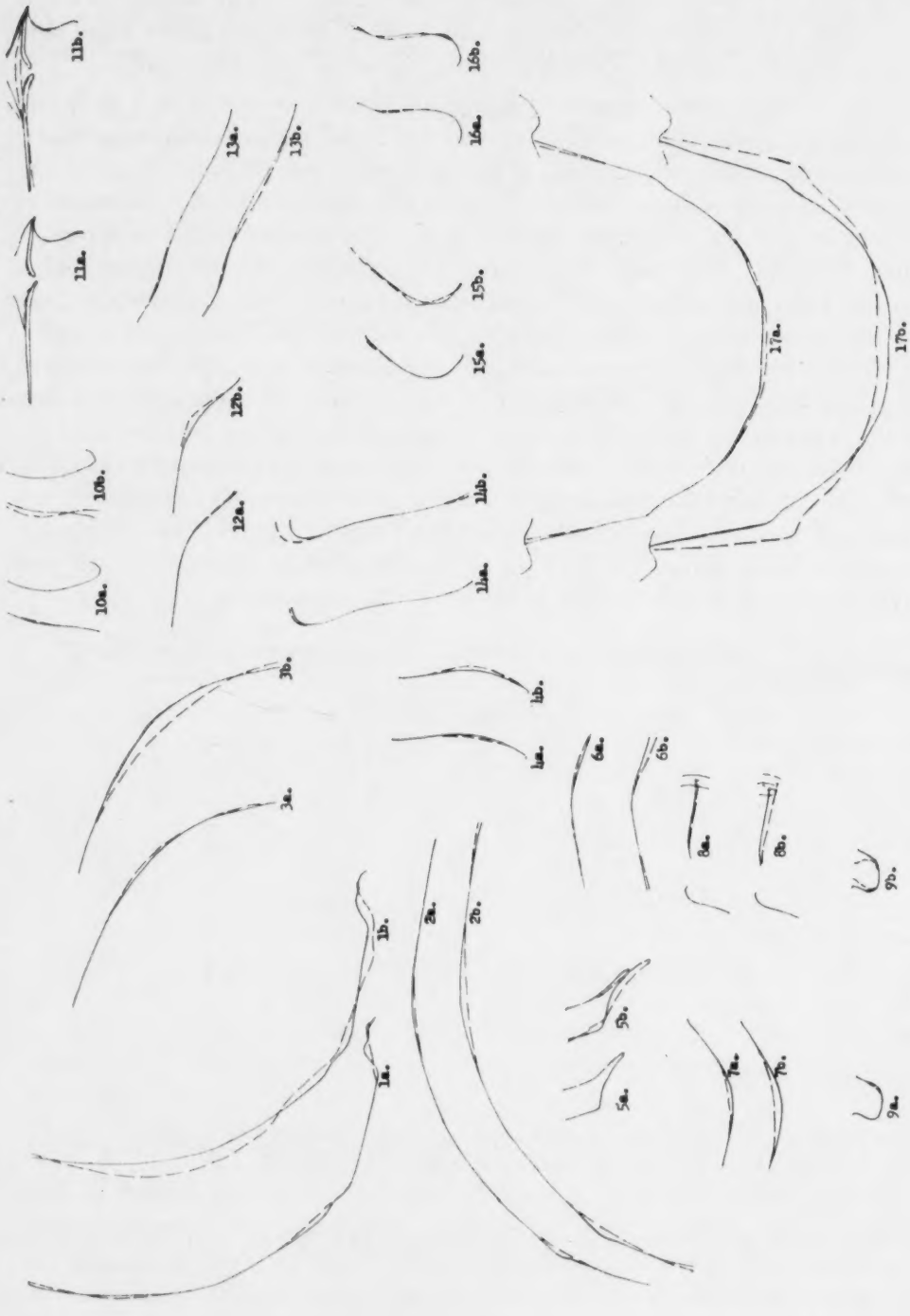


Fig. 7.—Example of concordance (*A*) and discordance (*B*) in seventeen individual bone traits.

In set No. 103, which is a triovular set, the relative amount of concordances for any possible pairing is less than 25 per cent. In set No. 109, which is a monovular set, the proportion of concordances ranges from 82 per cent to 94 per cent. In set No. 106, in which A and C (the pair designated by *3*) is monovular; the two diovular pairings have concordance proportions of 41 per cent each, while the monovular pair shows an 88 per cent concordance. The monovular pair A and B of set No. 107 shows concordance in all seventeen traits, but the two diovular pairings of this set show only an 18 per cent concordance. The monovular pair of set No. 108 is similarly distinguishable from the two diovular pairings, with a concordance proportion of 76 per cent as opposed to 23 per cent and 29 per cent.

Triplet set No. 111, which is triovular, offers additional rather dramatic evidence of the sensitivity of these bone traits to differential genetic constitutions. As has been observed earlier, it was impossible to diagnose dizygosity of B and C on the basis of blood groups and probability estimations based on parental blood groupings. The frequency of concordances in the three pairings of set No. 111—29, 47, and 35 per cent—can be interpreted only as evidence of the triovular origin of this triplet set.

The clear-cut correlations of these comparisons with the known zygosities of the triplets is evidence, we feel, of the predominant role of heredity in the formation of the skeletal units (the individual bones) of the craniofacial complex.

If we may project our results by ascribing to heredity the major role in creating the distinctive morphology of each bone, as that morphology is interpreted by lateral or frontal tracings, then we are confronted with a most interesting problem. It has been established, we believe, that two or three littermates having identical genetic constitutions will have practically identical bone morphology. Then why do these same persons develop facial and cranial profiles which are different in varying degrees and in various ways? The underlying bone structure may be identical; yet, the total configuration may be quite different. An interesting example may be cited at this point. If the lateral tracings of the mandibles of monovular twins are compared by registering on Po and superimposing the inferior border of the corpus, the rami will not necessarily superimpose. If the posterior borders of the rami are first superimposed with registry on the apex of the condyle, then the inferior borders of the corpus will not superimpose. Since both traits (posterior border of ramus and inferior border of corpus) superimpose independently (Fig. 7, *13a* and *14a*), the differentiating factor must be the gonial angle or, to put it more meaningfully, the way in which ramus and corpus have become related to each other. We can only speculate as to what forces operate on the mandible to alter this relationship, but if, within a single bony unit, relationships of one portion to another are dependent upon one or more unidentifiable environmental factors, then how may we interpret the craniofacial complex in which many bones somehow achieve an interrelationship that is characteristically human? These are interesting questions that arise out of the central problem of this article, but they will require much thought and perseverence and the application of techniques which are new or borrowed from other fields.

In searching for ways of identifying the contribution of heredity to the craniofacial complex, we were forced farther and farther away from a study of the craniofacial complex itself. We were led to the examination of elements of the complex as simple as could be discerned within the limitations of the roentgenographic cephalometric technique. Only when this happened did we strike "pay dirt." The various contours of individual bones reflect the strong control of genes. This led us to postulate that bones and segments of bones of the craniofacial complex are, in their morphologic configurations, subject predominantly to the influence of heredity. It seems apparent, however, that in their various inter- and intrarelationships which together make up a harmonious (or unharmonious) head and face, the environment is in the driver's seat.

SUMMARY AND CONCLUSIONS

In a study of six sets of same-sex triplets, the hypothesis of genetic determination of the craniofacial complex was tested. The major problem was to determine which, if any, traits of the craniofacial complex as defined in lateral and frontal headfilm tracings are amenable to heritability estimations. The use of triplets of the same sex offers distinct advantages over the usual twin method and is the best calculated of the various genetic methodologies for testing the hypothesis of heritability.

The twin study method raises the problem of zygosity diagnosis. In this article various techniques were followed to establish zygosity. They included blood grouping, probability estimations based upon parents' blood groups, lower first premolar structures, Carabelli's anomaly, fingerprint patterns and ridge counts, the taster test for sensitivity to phenylthiocarbamide, height, weight, and body build. Photographs in color and in black and white with head orientation in the Frankfort horizontal plane were presented in order to provide the reader with a general impression of physical appearance.

The value of each technique in estimating zygosity was discussed, and the following conclusions were reached: The use of blood grouping, premolar traits, ridge counts, and Carabelli's trait will together give highly reliable determinations of zygosity. Nevertheless only dizygosity can be indicated with certainty; monozygosity can be indicated only with a greater or lesser degree of probability. The use of the combined techniques affords the best probability estimate. It was pointed out that conclusions as to the operation of genetic factors which are based upon erroneous or inadequate diagnosis of zygosity are neither reliable nor valid.

Having established zygosity in each of the six triplet sets beyond a reasonable doubt, we compared the tracings of lateral and frontal headfilms by a variety of methods to determine whether identical and dissimilar genetic constitutions in littermates were reflected differentially in the craniofacial complex. A procedure of working from the complex to the simple was followed. The entire outline of the craniofacial skeleton, as observed in lateral headfilms, was examined as an entity. It was found that there was no correlation between variability and zygosity; hence, the craniofacial complex was just that—a complex of so many interactions of discrete elements and forces that the role of heredity could not be discerned, let alone estimated.

The craniofacial complex was then divided into its component parts—the cranial vault and the facial complex. By different methods of registry and superimposition, it was revealed that the cranial vault outline is really a composite, consisting of the outline of the calvarium and the outline of the cranial base. The different developmental histories of the calvarial bones and the cranial base give biologic reality to this conclusion. When each aspect of the cranial complex was examined singly, however, it was found that neither shows a positive correlation with zygosity; hence, neither is able to discriminate between predominance of heredity or of environment.

The facial complex was studied by means of a conventional type of polygon. With registry on sella, and superimposing S-N, tracings of monovular pairs afforded no greater concordance or discordance than did tracings of diovular pairs. The facial complex was then broken down into two component quadrilaterals—the upper facial and the maxillomandibular. A statistical approach was taken in which the four sides and the four angles of each quadrilateral were measured following the application of correction factors. The mean differences between each of eighteen pairings, six monovular and twelve diovular, were calculated and tests of significance were applied. It was found that there was no greater similarity in lengths of lines or degrees of angles in monovular twins than in diovular twins, in either the upper facial or the maxillomandibular complex. The utility of diameters and angles, which are in reality simply mental constructs, for recognizing the inheritance factor is brought into serious question.

The final operation in this study was to define aspects of individual bones, as observed in lateral and frontal headfilms, in terms of profile lines. The profile of an individual bone or segment of bone is one expression of the total morphologic configuration of that bone. It possesses the virtue of being closer to reflecting the operation of a single system of growth than any traits previously considered.

Seventeen such bone profiles were defined and examined. Comparison was made by attempting to superimpose the single bone profile tracings of monovular pairs and diovular pairs. Almost perfect concordance was the rule in monovular triplets, while only a low degree of concordance (below 50 per cent) was found in diovular triplets. It was thus demonstrated that the simplest type of trait —morphologic aspects of single bones—is the best indicator of the control of hereditary factors in the craniofacial complex. It was felt that zygosity could be determined in this way with the same high degree of reliability exhibited by blood groups, premolar traits, and ridge counts, taken singly or together.

From our study of seventeen bone traits defined in terms of lateral and frontal headfilm tracings, we might speculate that the morphology of all the bones of the craniofacial complex are under the rather rigid control of hereditary forces. If this be so, then how may we explain the variability in craniofacial outline that is as apparent in monovular littermates as in diovular and triovular littermates? It would seem that heredity governs morphology, but environment in its multitudinous facets has much to say about how these bony elements shall combine to achieve what interests us most—the harmonious (or unharmonious) head and face.

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THE ACRYLIC LABIAL ARCH

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THE number of original appliances used at present in orthodontic therapy is considerable. According to a recent orthodontic summary sheet from the Bureau of Dentistry, issued by the Department of Health of New York City, there are at least a dozen of these major appliances in current use. Moreover, the practitioner knows that each of the more important of the appliances has at least one or more variations of a particular kind or type. For example, the basic edgewise arch has burgeoned forth into many subtypes of the original Angle appliance. To be more specific, let me say that each orthodontist so uses and modifies what is known in our profession as the edgewise technique that it becomes more or less a matter of individual selection and application. Then, of course, there are many minor or unknown appliances, all with their various modifications, in the arsenal of the orthodontic clinician. Certainly, therefore, it is correct, speaking somewhat hyperbolically, to say that the modifications together with the original models make the number of appliances used in orthodontic treatment almost legion.

I have written this not in criticism but merely as a statement of existing facts in orthodontic therapy. There are, of course, those who hold that the lack of a single modus operandi in contrast to a number of treatment methods militates against the right of orthodontics to call itself a science. On the contrary, it is in the very nature of science to be experimental in the search for new, better, and even different methods of treatment. Does it matter, then, if the goal of successful treatment is reached by more than one road? Our own specialty has been enriched and has grown as a science (and, if you wish, also as an art) because of its dynamic qualities. Certainly, the great progress achieved in orthodontics has not been the result of any complete unanimity of thought. It is nearer the truth to say that progress has been due to new discoveries and new knowledge developed because of conflicting viewpoints. Naturally, it is much easier to think in the traditional mold than it is to create a new matrix into which one, so to speak, can pour new and original ideas. In the age of conformity in which we are living, this is especially true.

I should like to proceed with the immediate problem of the acrylic labial arch. However, I think that it is necessary first to say a few words about some

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of the prevailing ideas concerning anchorage in order to make clearer the reasons for the use of this arch.

No one, for instance, can help being impressed by the fine results achieved by Tweed's followers with their most carefully made mandibular anchorage preparation. On the other hand, there are the fine clinical results that have crowned the work of William L. Wilson[1] of Boston. Dr. Wilson employs an extremely simple form of anchorage, a variation of the Mershon lingual arch, the looped lingual arch.

Many orthodontists are asking themselves the following questions: "Is the so-called dynamic form of prepared mandibular anchorage a sine qua non of orthodontic treatment?" "Is it necessary?" "Can I simplify this procedure and still achieve a fine result?" The future alone can give the answer to the widespread use of prepared mandibular anchorage.

The effectiveness of root movement that employs tip-back bends and torque was the subject of a very provocative paper entitled "Tissue Changes Occurring During Orthodontic Movement in the Macaque Rhesus Monkey." It was read by Drs. Huettner and Whitman[2] at a meeting of the American Association of Orthodontists in New Orleans on May 14, 1957. The high light of the paper was the presentation of indisputable evidence as to the deleterious effect of the use of tip-back bends and torque forces. The evidence also showed that these forces produced extensive resorption to the roots of the banded teeth of the monkeys.

Consequently, many orthodontists have been alerted to the inherent disadvantages of a too rigid application of the mandibular anchorage as practiced by the devotees of Tweed. Orthodontists are relying more and more on natural evolution, not forgetting that while good anchorage is a prime essential in treatment, it should be achieved by less drastic and facile means. Many orthodontists are now attempting more pragmatic methods of anchorage control.

Among those who have been most successful in winning the attention of the profession is Bedell,[3] who uses tissue-bearing appliances for mandibular anchorage. Moyers and Higley[4] describe a stabilizing plate for the same purpose, thus doing away with the need for intricate mechanisms. Recently, Lusterman[5] has given the profession his tissue- and tooth-borne appliance. Leaving only the molar bands, he dispenses with the other bands later on in his treatment. An acrylic removable appliance is employed which permits minor changes in tooth movement and at the same time maintains an effective means of anchorage.

My own interest in the problem was primarily that of the clinical orthodontist; I was particularly concerned with the experimental aspects of our specialty. It was almost solely due to a question asked, I dare say, out of sheer curiosity by a teen-age girl patient about four years ago that I was stimulated to seek another means of mandibular anchorage. In this patient's case, the extraction of lower premolars was required, and I used the Bull method of space closure. After an appropriate interval, all the lower teeth were fully banded and the space closure was completed; a good arrangement of the teeth was

secured. As I was now ready for treatment in the maxillary arch, with the necessary premolar extractions, I so informed the patient. Unexpectedly, the patient, who was very bright, now posed the thought-provoking question: "Why aren't the lower bands removed now that the teeth are straight?" Taken somewhat aback, I gave her an explanation in nontechnical language of the reasons why the lower bands have to be left in place with the arch even though the teeth are evenly arranged and apparently corrected. After considerable deliberation and laboratory work, I surprised the patient, a month later, by removing all the lower bands with the exception of those on the molars. I inserted a modified heavy labial arch which was incorporated with an acrylic piece or attachment in conjunction with a fixed lingual arch. I felt it most appropriate to call this appliance the "acrylic labial arch." After this was applied as a means of anchorage to the mandibular arch, Class II elastics were used for about a year until the case was satisfactorily and uneventfully completed.

Following this happy experiment, the acrylic labial arch has been used very often in my practice, and I have found it to be extremely satisfactory. The use of this appliance as a simplification of mandibular anchorage control has also permitted me to remove the lower bands from eight to ten months sooner than it could otherwise have been done. Then, too, it has served with equal efficiency in nonextraction cases.

Specifically, the acrylic labial arch is an appliance that is characterized by an attachment which is incorporated into the anterior segment of a heavy labial arch. The patient inserts the appliance into and removes it from the buccal tubes of the molar bands. It is held in position passively by strong elastics (Fig. 1, *A*).

Now it is by virtue of the direction of the insertion, which is anteroposterior, that it is possible to fashion the quick-setting acrylic attachment to encompass the labial surfaces of the lower six teeth anteriorly from the gingival to the incisal regions as well as from canine to canine. The acrylic attachment is so precise in adaptation, because of the very nature of its fabrication that this encompassment even includes the interproximal surfaces. Moreover the grip or retention is so marked that, in essence, the function that it performs is equivalent to bands without many of the latter's well-known shortcomings. Thus, a unitization of the lower arch is attained. To be more specific, this is accomplished by virtue of the acrylic labial arch controlling the six anterior teeth from the labial aspect in combination with a simple fixed lingual arch controlling all the teeth from the lingual aspect (Fig. 1, *B*).

Again, by simple modifications, the acrylic arch can be made to perform other functions. To illustrate, merely by the addition of increments of the acrylic material, the acrylic attachment can be drawn out sufficiently to contact the lower lip. The muscles are employed as an activating posterior force to resist the displacing tendency of the lower anterior teeth from their base during Class II elastic application (Fig. 1, *C*). As for the ill effects of the lower lip when it is trapped by the maxillary incisors, in a number of Class II, Division 1 cases the studies done by White, Gardner, and Leighton[6] bear definite

proof. In Fig. 1, *D* the lower incisors are lingually inclined and crowded, and the dental length of the arch is decreased. This explains why the lower lip muscles can be harnessed to resist the displacement of the anterior teeth from their base. The addition of a plumper to the acrylic attachment will activate these muscles and lend them the necessary resistance.

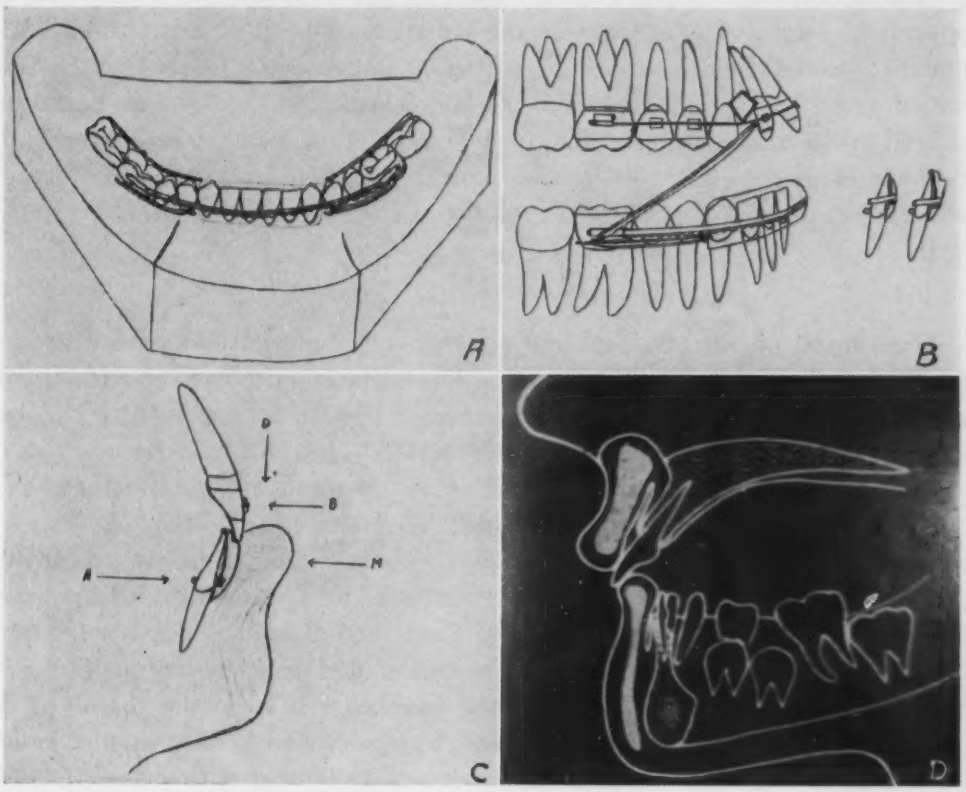


Fig. 1.—*A* and *B*, Drawings of acrylic labial arch setup. It is used in combination with a fixed lingual arch. Longitudinal sections of incisors in *B* illustrate modification of the acrylic attachment. *C* and *D*, For explanation, see text.

Another modification of the acrylic attachment will serve the purpose of covering the incisal edges with a ledge and a small tongue piece that will allow for a sufficient bite opening. As a result, the maxillary teeth are free of occlusal contact and are also permitted the freedom of downward movement. The idea of freeing the maxillary posterior teeth and not having any restraining measures during a particular period in treatment is supported by the weight of studies and authorities. Holdaway,[7] in a recent article, wrote: ". . . through studies, Ricketts and others have pointed out a decided tendency for faster downward growth of the teeth in the upper molar areas than in the upper incisor area during the usual age period in which orthodontic patients are treated."

In addition to the application of the usual appliance therapy, the maxillary incisors are at the same time aided in their efforts to move upward and backward by the inclined-plane effect of the acrylic ledge. The action is completed

when contact is made with the maxillary lingual surfaces of these teeth at a desirable axial inclination, that is, their crowns are kept slightly labial to their roots and work against any "rat" bite. The action of this inclined effect is a valuable auxiliary to the mechanical procedures which are often necessary for maxillary lingual root torque.

The patient is instructed to take out the appliance after each meal for the removal of detritus. Stops are at the mesial ends of the buccal tubes. The appliance itself is held securely in position by the patient's placement of strong elastics from hooks behind and below the buccal tubes to small gingivally soldered hooks in the region of the premolars. Here there is no active force; the sole purpose of the elastics is to keep the acrylic labial arch in place. Class II force cannot possibly displace the arch because of the much greater force holding it.

CONSTRUCTON OF ACRYLIC LABIAL ARCH

The initial operation is, of course, the fabrication of the modified arch in preparation for the acrylic attachment. This attachment can be made directly in the mouth or the acrylic can be constructed first on the model with the final adaptation of the lower anterior teeth made in the mouth. Because of its sequence, this latter application can be called the indirect-direct method.

Here the indirect-direct method will be described. In the mandible all bands except the molar bands are removed. If there is a lingual or buccal tube it should be left on, since it serves as a means of accurate seating of the bands in the alginate impression. A soldered fixed lingual arch is constructed on a model. When at all possible, second molars should be included, making wire contact on the lingual surfaces of all the teeth as well as on the cinguli of the lower anterior teeth. Two ¼ inch buccal tubes are soldered on the molar bands, and a heavy steel arch (0.040 inch) is shaped and fitted with marks made in front of the mesial ends of the buccal tubes. Then the arch is removed and prepared for the welding of the continuous 0.036 inch eyelets. These eyelets are made by punching out 0.020 inch dead soft S.S. wire with simple modified pliers (Fig. 2, *A*). An adequate length is next welded gingivally from the mesial mark on the arch to that of the opposite side. A fine-pointed electrode is placed between the crests of the eyelets, and a groove electrode is used to hold the heavy arch wire. The heavy arch has been converted into a perforated one which will fix the acrylic attachment firmly to it. Easily and securely, the soft 0.020 inch wire welds itself to the arch wire as the dead soft wire flattens somewhat against the arch, absorbing all the heat in the process without, however, damaging it (Fig. 2, *B* and *C*). Solder is added to reinforce the welds for adequate stops and also to prevent the disunion of eyelets and arch wire. At a point between the canine and the premolar, two 0.029 inch soft S.S. wire hooks are soldered gingivally. Enough solder is used to enclose soft and hard wire for additional reinforcement. The hooks should be small.

The anterior teeth, to continue with the process, are covered with tin foil to permit the subsequent removal of the acrylic attachment. About 1 c.c. of

monomer is placed in a receptacle and clear polymer is then added to saturate the liquid. After a minute or so, the ingredients in the receptacle become quite doughy and can now be manipulated with one's fingers to the length of 1 inch.

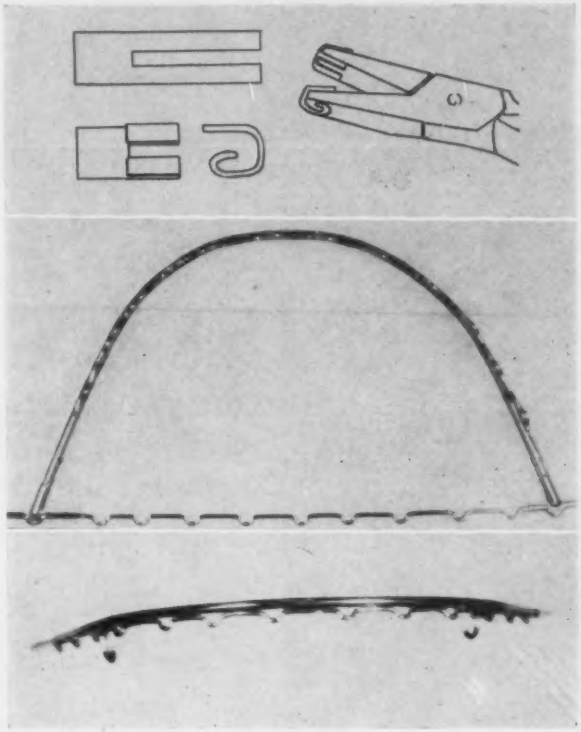


Fig. 2.—*A*, Drawings of dies for making modified pliers. *B*, Continuous eyelets punched out from soft steel wire and welded onto heavy arch. Arch is now *perforated*. *C*, Front view of modified arch.

The material is then pressed into the eyelets and wrapped around the anterior segments of the arch. The arch is inserted into the buccal tubes all the way until it can go no further because of the stops. Very quickly, the acrylic is molded against the labial surfaces of the anterior teeth from the gingival to the incisal aspects and from canine to canine. The acrylic piece should extend about 2 mm. below the cervical line. After setting, the tin foil is removed from inside the acrylic piece. It is roughened with a round burr on the inside and polished with pumice (Fig. 3). Should any accretions of acrylic be necessary later, they can be made.

The appliance is now ready to be checked and fitted in the mouth of the patient in the chair. The soldered lingual arch with band is first cemented in the mouth, and now everything is set for the final fitting of the labial arch. A small mixture of clear acrylic is made and applied with a brush to the inner surface of the acrylic attachment. The arch is quickly inserted into the buccal tubes all the way to the stops. The last step is very important, since its purpose is to obtain a perfect adaptation of the labial surfaces of the natural teeth, especially the interproximal areas which are essential for the adequate control of these teeth from adverse and undesirable movement.

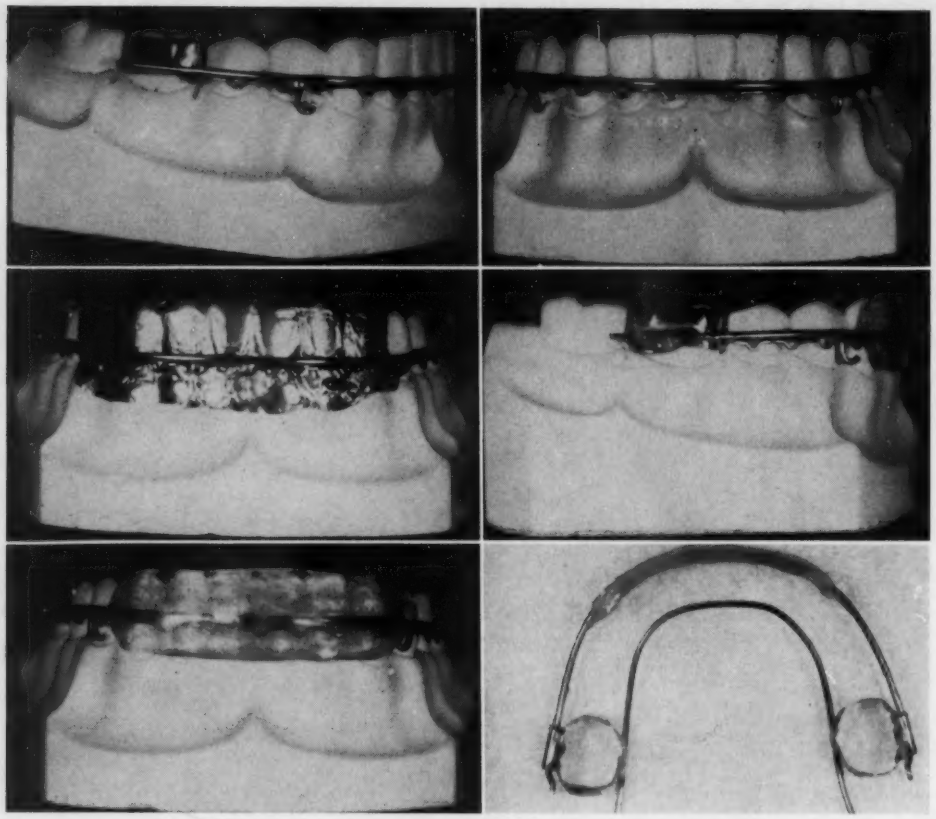


Fig. 3.—Progressive steps in construction of labial acrylic arch.

CASE REPORTS

Case 1, Patient L. F. (Fig. 4).—This was a Class I case with extremely protruding maxillary teeth. The case appeared to be an easy one, and it seemed that it could be resolved in a short time by the application of extraoral force and a simple elastic to press against the maxillary incisors. However, the patient refused to wear the extraoral appliance. I did not discontinue the case. Instead, I tried the acrylic labial arch in conjunction with the fixed lingual arch and with Class II elastics as the source of anchorage. The patient was most cooperative in using the elastics.

Case 2, Patient J. L. (Fig. 5).—This was a Class II, Division 1 case. Here extraoral therapy failed to achieve distal movement of the maxillary posterior teeth. It appeared that there was no choice but to compromise in treatment by extracting the premolars. I decided on second thought, however, to see whether or not the use of the acrylic labial arch in conjunction with the fixed lingual arch would resolve the problem. Six months later, with the use of Class II elastic anchorage, the maxillary posterior molars and premolars were moved distally into their normal mesiodistal relationship. After a few more months the canines were in their proper position. Finally, the maxillary incisors were moved into their correct overjet and overbite relationship. The entire treatment took thirteen months. Yet, it took almost a year to learn the absolute futility of using extraoral therapy in this case.

Case 3, Patient C. A.—This was a Class I bimaxillary protrusion case (Fig. 6) which required the extraction of four premolars. After the lower arch was properly aligned, subsequent to the extraction of the lower premolars with leveling closure of spaces and paralleling

of roots, all the bands except those on the molars were removed. In order to prevent the lower molars from moving forward, it was necessary, of course, to use extraoral force. Therefore, a fixed lingual arch was inserted, together with an acrylic labial arch.

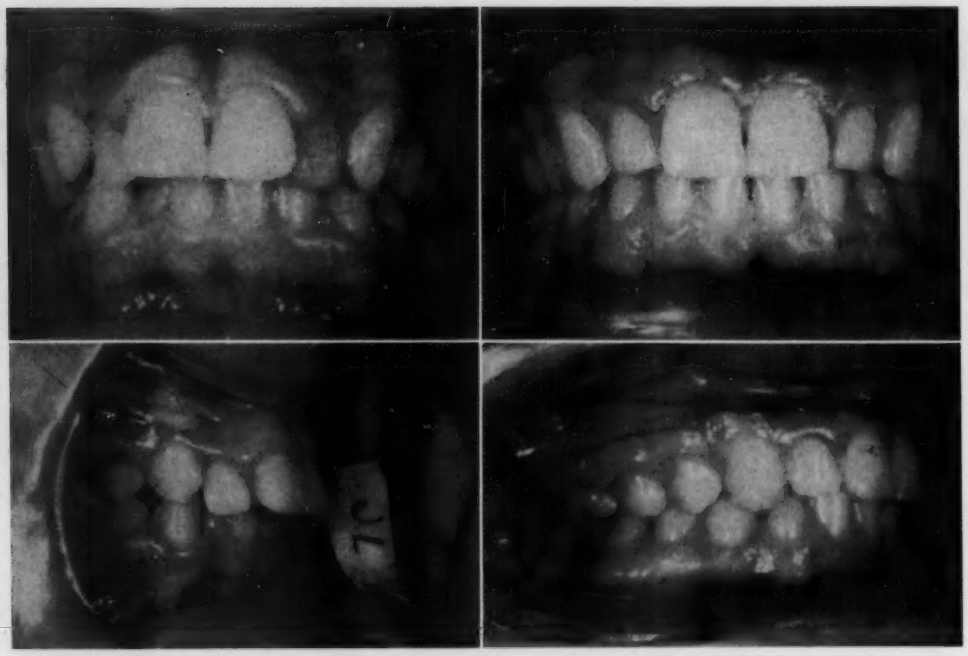
After the routine premolar extractions in the maxillary arch, the usual technique of space closure was instituted. During the mechanical procedures in the maxilla, the lower arch with the above-mentioned appliances was used as a Class II anchorage. In this way, a period of from eight to ten months of wearing bands in the lower jaw was eliminated.

Fig. 7 shows occlusal views of models before and after treatment.

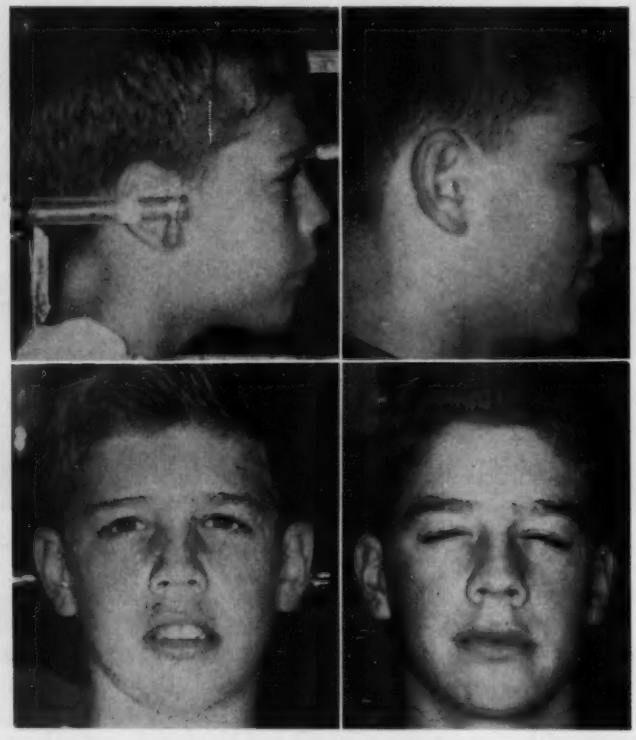
Fig. 4.—Case 1, Patient L. F. Pretreatment and progress photographs.

Case 4, Patient R. T. (Fig. 8).—This was a Class II, Division 1 bimaxillary protrusion case. Here, too, four premolars were extracted, and treatment followed the same pattern as in Case 3. It will be noted, however, that the patient in this case shows a more pronounced facial disharmony and aberration of the jaws than Patient C. A. in Case 3. It was necessary to resort to both passive and active extraoral force in addition to the use of Class II elastics. The elastics were applied to the mandible, which had the acrylic arch in conjunction with the fixed lingual arch.

It will be noted that the patient had sustained a fracture of the maxillary right central incisor, which subsequently required root canal therapy.

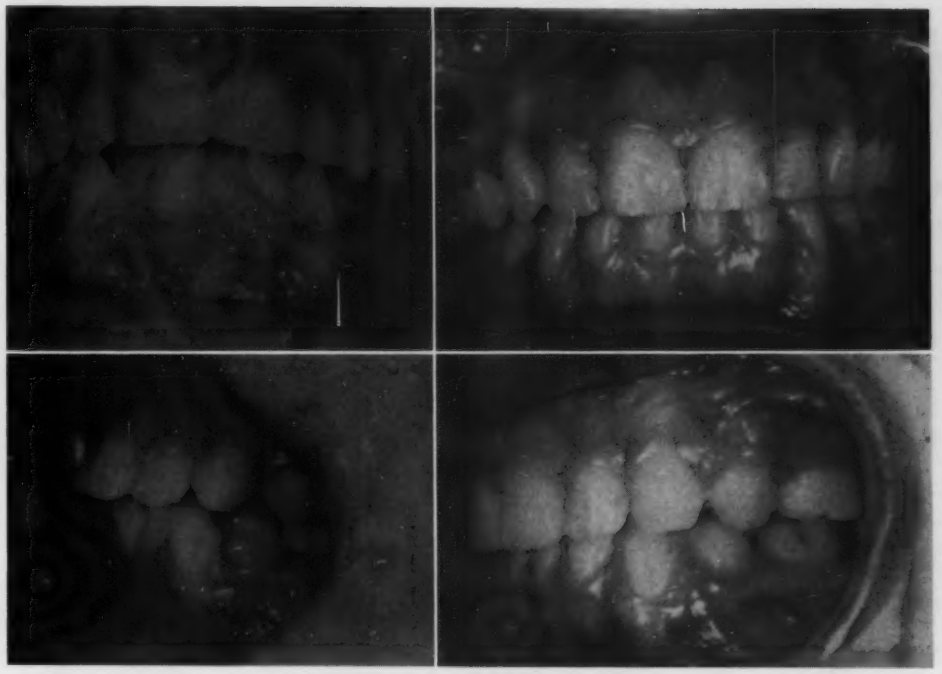


A.



B.

Fig. 5.—Case 2, Patient J. L. Before and after treatment.



A.

B.

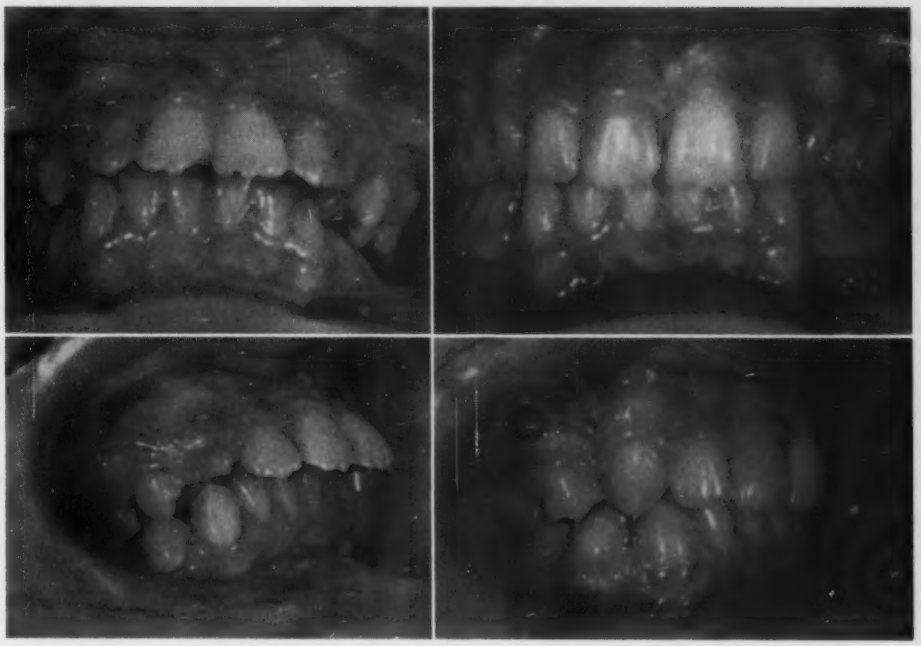
Fig. 6.—Case 3, Patient C. A. Before and after treatment.

Skepticism as to the effectiveness of Class II intermaxillary traction has recently been increasing. As a counteraction, in an effort to overcome some of the shortcomings, orthodontists are more and more utilizing extraoral therapy instead. Moreover, like most converts, they see practically no virtue at all in the "old" therapy and are fanatical about the virtues of the new therapy. As a natural corollary to this fanaticism, the most extravagant claims are put forth.

Fig. 7.—Case 3, Patient C. A. Models before and after treatment.

Unwarranted use of extraoral therapy may again create a reaction against it. Graber,[9] who has made an extensive study of this appliance, has shown some disadvantages of extraoral force when it is employed as the only therapy. Among the untoward results are the following: "Incomplete correction of tooth malrelationship, excessive distal tipping of maxillary first molars, possible excessive lingual tipping of maxillary incisors, possible unilateral response in correction of Class II relationship, and difficulty in control of excessive overbite."

A proper understanding of the respective roles played by both forms of anchorage is an invaluable aid toward achieving satisfactory results. Viewed objectively, Class II anchorage appears to improve facial esthetics and to affect mandibular growth. This conclusion has been confirmed through the observation of many cases. Holdaway[7] refers to this as the "Tweed type of mandibular growth response" and then adds the following stricture: ". . . not because Tweed is the only orthodontist who gets such a response, but because of greater



A.

B.

Fig. 8.—Case 4, Patient R. T. Before and after treatment.

frequency and extent of such responses among his patients." In this connection, attention is directed to Cases 2, 3, and 4, in which the photographs illustrate the improvement in facial esthetics and growth response as a consequence of Class II intermaxillary traction.

CONCLUSION

The acrylic labial arch is a simplification of mandibular anchorage control and can be used effectively in both extraction and nonextraction cases. The primary requirement for its successful use is that the arch should be a good one. It is possible to eliminate bands much sooner in extraction cases than in nonextraction cases and still maintain adequate anchorage. In nonextraction cases, if the lower arch permits, the appliance can be inserted at the beginning of the treatment or after the corrections have been made. The lower lip muscles are utilized as deterrents to prevent the displacement of the anterior teeth from their base. As for the acrylic labial arch itself, it becomes a bite opening appliance, allowing the posterior teeth to move in a downward position while the upper incisors can move upward and backward at a determined axial inclination. This two-pronged effect is a check against the tendency toward ratbite.

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182-01 UNION TURNPIKE

Forthcoming meetings of the American Association of Orthodontists:
1959—Statler Hotel, Detroit, Michigan, May 4 to 7.
1960—Shoreham Hotel, Washington, D. C., April 24 to 28.
1961—Denver, Colorado.
1962—Los Angeles, California.

Department of Orthodontic Abstracts and Reviews

Edited by
DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City.

Handbook of Orthodontics: By Robert E. Moyers, D.D.S., Ph.D., Professor of Dentistry (Orthodontics), School of Dentistry, University of Michigan. Chicago, 1958, Year Book Publishers, Inc. 498 pages. Illustrated.

This handbook serves its purpose in an admirable fashion as an introduction to students and general dentists in the principles of orthodontics. In the words of the author, it "presupposes very little background on the part of the reader. It really has two purposes: to serve as an introductory text for students who intend to become general practitioners, and to supply to those in dental practice who did not have the benefits of a recent undergraduate course in orthodontics fundamental knowledge that may be applied in the day-by-day practice of dentistry."

The book is divided into three principal sections: growth, diagnosis, and treatment. The section on growth is particularly well conceived; it starts out with the embryology of the face and cranium, continues with the development of the deciduous and permanent dentitions, and concludes with the changes that take place in the masticatory system during maturity. Other chapters in this section consider the growth of cranial and facial bones, the role of musculature in the development of the face, and the etiology of malocclusion.

The first chapter on diagnosis discusses the importance of the original examination; it stresses complete records and provides excellent charts from the State University of Iowa on general growth and on the normal size, position, and eruption of the teeth. The chapter on classification lists the various "systems" in orthodontics, with emphasis on the familiar Angle method. This is followed with comments on the indications for treatment in the deciduous, mixed, and permanent dentitions.

The first chapter in the section on treatment is devoted to clinical orthodontics. A full discussion is given on missing, impacted, submerged, and supernumerary teeth. Also described are cross-bites, open-bites, discrepancies in tooth size, arch length measurements, the labial frenum, and correction of Class II and Class III irregularities. This chapter concludes with a discussion of gross facial deformities, such as mandibular prognathism and cleft lips and palates.

The second chapter in this section deals with the general dentist's responsibilities in making the original diagnosis and in securing proper references. The final chapter is devoted to techniques, materials, and instruments. It describes the various appliances currently in use in orthodontics and gives instructions in the construction of bands, arch wires, acrylic bite planes, head

gear, Hawley retainers, space maintainers, and the Higley stabilizing plate. The text is concluded with a competent discussion of myofunctional therapy and the occlusal equilibration of teeth.

If any criticism is to be made of the book, it would deal with the emphasis on complex mechanical procedures in an orthodontic text for general dentists; nearly two-thirds of the book is devoted to appliances, several of which tax the ingenuity of the experienced orthodontist. The general dentist is much too busy with the complicated techniques of his own procedures to want to become involved in the equally intricate mechanical details of orthodontic treatment.

He wants, instead, more explicit information on the etiology and preliminary diagnosis of malocclusion so that he can guide his patients in an intelligent manner prior to orthodontic consultation. He is aware of current advances in orthodontic diagnosis, and he realizes that some of these procedures can also be applied to problems in general dentistry. Yet, the diagnostic methods of cephalometrics, widely used by American orthodontists, are scarcely mentioned in this text, whereas a detailed technical description is given to the European systems of monoblocks and oral shields which are rarely applied by American orthodontists to accomplish the treatment detail they strive to achieve.

A point in question is the discussion on serial extraction. Salzmann stated the problem correctly in an editorial warning to orthodontists in the November, 1958, issue of the AMERICAN JOURNAL OF ORTHODONTICS: "This procedure requires a fine diagnostic sense and wide clinical experience, especially as to *whether* and *when* it should be performed." If the experienced orthodontist needs to be warned about its dangers, certainly the general dentist will want no part of it.

The paragraphs on serial extraction also need clarification. The casual reader will gain the impression that deciduous teeth are removed in a serial manner to encourage the early eruption of the permanent cuspids. Actually, serial extraction is a procedure designed not to promote cuspid eruption, as the author seems to imply, but instead to ensure prompt eruption of the first premolar so that the cuspid can erupt of its own accord into the remaining space after the first premolar has been extracted. The text carries a proper warning as to the dangers of serial extraction; yet, is should have been more emphatic in stressing that it is applied only in marked discrepancy irregularities and that the orthodontist is the one who must assume the responsibility for the diagnosis and treatment of these critical conditions.

Nevertheless, this handbook of orthodontics fills a need for the general dentist, and the specialist will find it of more than passing interest. It is well illustrated with clinical photographs, line drawings, and appropriate tables, and it is printed with a legible type face on a high-quality paper.

B. F. Dewel.

News and Notes

American Association of Orthodontists
Registration of Nonmembers for Attendance at Annual Sessions

To ensure full participation of all active members of the American Association of Orthodontists, the following classification of nonmembers eligible to attend and schedule of attendance fees, which will be charged at the time of registration, has been set up for the coming annual session of the Association at the Statler-Hilton Hotel, Detroit, Michigan, May 3 to 7, 1959.

A. *No Attendance Fee.*

1. Full-time teachers in university dental schools.
2. Full-time graduate or postgraduate students in university orthodontic departments. It will be necessary to present a letter from the dean of the school certifying the status of the student.
3. Dentists from outside Canada or the United States of America who are members of recognized dental or orthodontic organizations.

B. *Attendance Fee—$10.00.*

1. Associate or junior members of constituent societies of the American Association of Orthodontists.
2. Recent graduates of university orthodontic departments who are in Government Service.

C. *Attendance Fee—$20.00.*

1. Recent graduates of university orthodontic departments who are not members of constituent societies of the American Association of Orthodontists.
2. Other guests.

Those persons who would be classified under the heading of C-1 or C-2 above are required to apply to the chairman of the Credentials Committee at least sixty days before the session for proper forms, which will require (a) written endorsement by two active members of the A.A.O. in the applicant's vicinity, (b) that the applicant be a member in good standing of the American Dental Association, and (c) that the applicant never has been rejected for membership in any of the constituent societies of the A.A.O.

Those persons who would be classified under the headings of A or B would be required only to submit credentials identifying themselves as being in one of these categories at the time of registration. Advanced reservations, which are by far most desirable, can be applied for by clearing one's credentials with the Credentials Committee by March 1, 1959.

Registration under categories C-1 and C-2 will, of necessity, be limited.

David L. Hall, Chairman
Credentials Committee
660 Cadieux Rd.
Grosse Pointe 30, Michigan

American Association of Orthodontists
Fifty-fifth Annual Session
Statler-Hilton Hotel
Detroit, Michigan
May 3-7, 1959

We look forward sincerely to welcoming you in Detroit, hoping to make your visit one of leisure, comfort, and inspiration.

In some respects we have great need for your help in attaining those objectives, and an attempt will now be made to suggest how you may help to make the Detroit meeting a more pleasant experience.

Recently, members of the A. A. O. received from Secretary Shepard the following:

1. Card for hotel room reservations.
2. Card to register attendance at the session.
3. Form on which to express preference at Limited Attendance Clinics.
4. Form on which to make reservations for social functions.

It is suggested that you complete these forms as quickly as possible, according to directions, and return them as specified. You will thus be considered to be "preregistered," and all you will have to do is walk up to the "Preregistration Desk," sign your card, and collect your tickets. There will be no waiting, no confusion.

For those who do not "preregister," there is chance of confusion and delay. As a matter of fact, any preregistrations received without payment for social functions, where requested, will not be honored.

Your pleasure will be greatly enhanced by observing the above suggestions. Whenever you are requested to print your name, please do so, since at former meetings many reservation requests were delayed by an illegible signature.

Please do not return application for social functions or checks in the ballot envelope.

When arrangements were made for this session three years ago, it was felt that the facilities of the Statler-Hilton Hotel would be more than adequate. With our organization increasing in size so greatly, it is now recognized that the plans of 1956 do not fit the requirements of 1959. Accordingly, provisions were made to house the overflow in the Tuller Hotel, just across the street. We have 275 rooms there, swelling our total hotel reservations to 875 rooms.

The January, 1959, issue of the JOURNAL carried a preliminary outline of the program. It is being repeated in the present issue in a more nearly complete form.

Sunday, May 3

10 A.M. to 5 P.M.	Registration, Grand Ballroom Foyer.
10 A.M. to 5 P.M.	Board of Directors Meeting, Ivory Room, Ballroom floor.
12 Noon.	Board of Directors Luncheon, Parlor E, Ballroom floor.
5:30 P.M. to 7:30 P.M.	Champagne Reunion, Grand Ballroom.

Monday, May 4

8 A.M. to 5 P.M.	Registration, Grand Ballroom Foyer.
9 A.M. to 5 P.M.	Exhibit of Case Reports by the 1958 diplomates of the American Board of Orthodontics, Bagley Room, Ballroom floor.
8 A.M.	Publications Committee Breakfast, Parlor E, Ballroom floor.
8 A.M. to 5 P.M.	Commercial Exhibits, Wayne Room, Ballroom floor.
8:30 A.M. to 10:30 A.M.	Ladies' Continental Breakfast, Michigan Room, Ballroom floor.

12:15 P.M. Golden Anniversary Luncheon (Dr. Charles R. Baker, presiding), Grand Ballroom.

12:30 P.M. Ladies Luncheon, Sheraton-Cadillac Hotel.

8 A.M. Breakfast, Southern Society of Orthodontists, Executive Committee, Parlor C, Ballroom floor.

9 A.M. Official Opening of the Meeting. President C. Edward Martinek.
Invocation. The Rev. Lawrence H. Ashlee, St. Matthias Church, Detroit, Michigan.
Address of Welcome. Louis Miriani, Mayor, City of Detroit.
Response. Dr. George M. Anderson, President-Elect of the American Association of Orthodontists.
President's Address. Dr. C. Edward Martinek.

SCIENTIFIC MEETING, Grand Ballroom

(Presiding, Scott T. Holmes, Program Committee Chairman)

10 A.M. The Philosophy of Orthodontic Diagnosis. Dr. Wendell L. Wylie, San Francisco, California.

11:15 A.M. The Physiologic Bases for Jaw Relationships. Dr. Robert E. Moyers, Ann Arbor, Michigan.
(An original thesis presented to the American Board of Orthodontics toward certification)

12:15 P.M. Golden Anniversary Luncheon, Grand Ballroom.

1:45 P.M. Presentation of the Albert H. Ketcham Memorial Award of the American Board of Orthodontics.
Presented by Dr. William R. Humphrey, Denver, Colorado, President, American Board of Orthodontics. Accepted by Drs. Allan G. Brodie, Chicago, Illinois, and Robert H. W. Strang, Bridgeport, Connecticut.

2:30 P.M. The Role of Diagnostic Aids in the Development of a Diagnosis. Dr. Alton W. Moore, Seattle, Washington.

3:45 P.M. Milo Hellman Research Award. Reading of the Prize Winning Essay and Presentation of the award by President Martinek.

Tuesday, May 5

8 A.M. to 5 P.M. Registration, Grand Ballroom Foyer.

8 A.M. to 5 P.M. Commercial Exhibits, Wayne Room, Ballroom floor.

9 A.M. to 5 P.M. Exhibit of Case Reports by the 1958 diplomates of the American Board of Orthodontics, Bagley Room, Ballroom floor.

8 A.M. Breakfast, A. A. O. Board of Directors, Parlor E, Ballroom floor.

8:30 A.M. to 10:30 A.M. Ladies' Continental Breakfast, Michigan Room, Ballroom floor.

12:30 P.M. Mixed Luncheon, Grand Ballroom (attendance limited to 600 people). Reservation requests will be honored in the order in which they are received.

SCIENTIFIC MEETING, Grand Ballroom

(Presiding, Carl R. Anderson, Program Committee Co-Chairman)

9 A.M. The Development of a Treatment Plan in the Light of One's Concept of Treatment Objectives. Dr. Joseph Jarabak, Hammond, Indiana.

10:15 A.M. The Development of a Treatment Plan in the Light of One's Concept of Treatment Objectives. Dr. William L. Wilson, Boston, Massachusetts.

The Rouge plant of the Ford Motor Company is the world's greatest industrial concentration—more than 1,200 acres of factories, foundries, steel mills, paper mill, glass plant, power plants, coke ovens, ship docks, and private railroad lines. More than 63,000 men and women are employed here.

11:30 A.M. First business meeting of the American Association of Orthodontists, Grand Ballroom.

12:30 P.M. Mixed Luncheon, Grand Ballroom.

2 P.M. to 5 P.M. RESEARCH SECTION, Michigan Room, Ballroom floor

(Presiding, Dr. J. William Adams, Chairman, Research Committee)

The Research Section of the Fifty-Fifth Session of the American Association of Orthodontists is respectfully dedicated to the memory of Dr. Milo Hellman. A supplement to the research program, issued at time of registration, contains the details of this phase of the program. Each report will be limited to ten minutes.

Wednesday, May 6

8 A.M. to 5 P.M. Registration, Grand Ballroom Foyer.

8 A.M. to 5 P.M. Commercial Exhibits, Wayne Room, Ballroom floor.

8 A.M. Breakfast for 1960 Program Committee, Parlor F, Ballroom floor.

8 A.M. Secretaries' Breakfast, Parlor E, Ballroom floor.

9 A.M. to 5 P.M. Exhibit of Case Reports by the 1958 diplomates of the American Board of Orthodontics, Bagley Room, Ballroom floor.

12:15 P.M. Past Presidents' Luncheon, Parlor E, Ballroom floor.

SCIENTIFIC MEETING, Grand Ballroom

(Presiding, Edward A. Cheney, Chairman, Limited Attendance Clinics and General Table Clinics)

9 A.M. Table Clinics, Grand Ballroom, Michigan Room, English Room and Ivory Room.

2 P.M. Limited Attendance Clinics (rooms to be assigned).

The theme of the Limited Attendance Clinics will be "Diagnosis, Treatment Planning and Appliance Therapy." Each speaker has been asked to present cases in which he will thoroughly cover preliminary study, the use of diagnostic aids, the formulation of a diagnosis, the development of a treatment plan, and finally the appliance therapy. Attempts have been made to select men who will use various types of appliance therapy.

6:30 to 7:30 P.M. President's Reception and Cocktails, Oak Foyer, Michigan Room and English Room, Ballroom floor.

7:30 P.M. Banquet, Grand Ballroom (music by a name band).

Thursday, May 7

8 A.M. to Noon. Registration, Grand Ballroom Foyer.

8 A.M. to Noon. Commercial Exhibits, Wayne Room, Ballroom floor.

9 A.M. to Noon. Exhibit of Case Reports by the 1958 diplomates of the American Board of Orthodontics, Bagley Room, Ballroom floor.

SCIENTIFIC MEETING, Grand Ballroom

(Presiding, Ernest N. Bach, Vice-President, American Association of Orthodontists)

9 A.M. Orthodontics in 1969, Dr. Tom Graber, Chicago, Illinois.

10:15 A.M. Orthodontics in 1969, Dr. Harold Hillenbrand, Chicago, Illinois.

11:30 A.M. Second Business Meeting of the American Association of Orthodontists.
1. Installation of officers.
2. Presentation of the past-president's key to C. Edward Martinek by Franklin A. Squires.

12:30 P.M. Adjournment.

The committees have endeavored to make this an outstanding session. We sincerely hope that you will leave Detroit having learned a little more, having enjoyed our efforts to provide a little relaxation, and believing it has been our pleasure to serve you.

Scott T. Holmes, Program Chairman
Edward A. Cheney, Clinic Chairman
George S. Harris, Banquet and Entertainment
Robert Coleman, Local Arrangements Chairman
Barnett Malbin, Exhibits Chairman.

Research Committee
American Association of Orthodontists

The Research Committee has made a special effort to not only fulfill its usual assignments but also contribute to a fine program being worked out under the guidance of President Martinek. We hope that orthodontists associated with teaching institutions in particular, as well as members of the American Association of Orthodontists in general, will show their interest by attending the parts of the program in which your Research Committee is concerned.

A fine group of essays were received in competition for the 1959 Milo Hellman Award and judged under the supervision of Dr. Faustin Weber. The papers selected for special recognition are of unusually good quality and deserve the special attention of all practicing orthodontists.

Dr. Richard Riedel is in charge of the research abstracts this year and is very busy arranging them into a helpful and interesting part of the program. A lot of stimulating discussion by capable clinicians can be expected.

J. William Adams, Chairman
Research Committee.

Progress of Keogh-Simpson Bill

Many professional men have written to inquire about the current status of the Keogh-Simpson Bill. The Keogh-Simpson Bill allows self-employed persons to provide for their own retirement.

The Keogh-Simpson Bill (H.R. 10 and 10) allows a self-employed person to deduct from gross income each year a limited amount of self-employment income contributed by him to a restricted retirement fund or paid in as premiums to purchase an insurance policy with retirement features. He can deduct each year up to $2,500.00 or 10 per cent of self-employment income, whichever is less, but not more than a total of $50,000.00 during his lifetime.

A person who has reached the age of 50 before the effective date is allowed to deduct an additional amount to help him build up an adequate interest in the fund or obtain more than a token annuity.

If your congressman is one of the sixteen sponsors of the Keogh-Simpson Bill, he would no doubt appreciate the views of professional men in letters or telegrams. If he is not a sponsor then he no doubt would appreciate hearing from his constituents as to how they feel about the bill.

Finance and Ways and Means Committee Assignments.—The two key committees with respect to the Keogh-Simpson Bill are the Senate Finance and the House Ways and Means Committees. Members of the respective committees, together with their party and home residence, are as follows:

Finance

Democrats	*Republicans*
Byrd (Merryville, Virginia), Chairman	Williams (Dover, Delaware)
Kerr (Oklahoma City, Oklahoma)	Carlson (Concordia, Kansas)
Frear (Dover, Delaware)	Bennett (Salt Lake City, Utah)
Long (Baton Rouge, Louisiana)	Butler (Baltimore, Maryland)*
Smathers (Miami, Florida)	Cotton (Lebanon, New Hampshire)
Anderson (Albuquerque, New Mexico)	Curtis (Minden, Nebraska)*
Douglas (Chicago, Illinois)	
Gore (Carthage, Tennessee)	
Talmadge (Lovejoy, Georgia)*	
McCarthy (St. Paul, Minnesota)*	
Hartke (Evansville, Indiana)*	

Ways and Means

Democrats	*Republicans*
Mills (Kensett, Arkansas), Chairman	Reed (Dunkirk, New York)
Forand (Cumberland, Rhode Island)	Simpson (Huntingdon, Pennsylvania)
King (Inglewood, California)	Mason (Oglesby, Ohio)
O'Brien (Chicago, Illinois)	Byrnes (Green Bay, Wisconsin)
Boggs (New Orleans, Louisiana)	Baker (Huntsville, Tennessee)
Keogh (Brooklyn, New York)	Curtis (Boston, Massachusetts)
Harrison (Winchester, Virginia)	Utt (Santa Ana, California)*
Karsten (St. Louis, Missouri)	Knox (Sault Ste. Marie, Michigan)*
Herlong (Leesburgh, Florida)	Betts (Findlay, Ohio)*
Ikard (Wichita Falls, Texas)	Alger (Dallas, Texas)*
Machrowicz (Hamtramck, Michigan)	
Fazier (Chattanooga, Tennessee)*	
Green (Philadelphia, Pennsylvania)*	
Watts (Nicholasville, Kentucky)*	
Metcalf (Helena, Montana)	

Tax Report
A Special Summary and Forecast of Federal and State Tax Developments†

A bill to defer taxes on self-employed retirement plans is backed by House leaders.

Chairman Mills of the Ways and Means Committee agrees to press for a quick vote on the measure that passed the House but not the Senate in the last session of Congress. The bill, authored by Rep. Keogh (D., N. Y.), would let doctors, lawyers, and other self-employed persons deduct up to $2,500.00 of income a year set aside in retirement plans, for a maximum of $50,000.00 over 20 years. Pension benefits would be taxable only when received, as is the case with employed persons covered by existing pension plans.

Key House lawmakers are just about convinced that tax-deferred retirement plans for the self-employed will receive full Congressional approval sooner or later. So they decided

*New committee member.
†Extract from *The Wall Street Journal*, Wednesday, Jan. 28, 1959.

to get the measure quickly out of the way of this session. But House action would put the problem up to Senate Finance Committee Chairman Byrd, who is cool to the idea.

The Treasury also is opposed to it; officials say the program would cost $365 million a year in now badly needed revenue.

Fund for Dental Education

The election of Robert Kerr, Jr., president of the Kerr Manufacturing Company of Detroit, Michigan, and Henry M. Thornton, president of the Dentists' Supply Company of New York, of York, Pennsylvania, to the Board of Directors of the Fund for Dental Education has just been announced by the Fund's president, Maynard K. Hine, D.D.S., of Indianapolis, Indiana.

In making this announcement, Dr. Hine, who is also Dean of the Indiana University Dental School, pointed out that Mr. Kerr and Mr. Thornton have the honor of being the first laymen elected to the Board of this national fund-raising organization for dental education. Heretofore, the Board has been composed only of dental educators.

The selection of Mr. Kerr and Mr. Thornton for this honor, Dr. Hine said, was made on the basis of their outstanding service to the dental profession and particularly because of their interest in dental education.

The Fund for Dental Education was organized in 1956 to assist the forty-seven dental schools in this country and five dental schools in Canada in raising funds for dental education. Fund-raising efforts are concentrated largely among members of the dental profession, dental manufacturers, business, foundations, and persons concerned over the impending shortage of dentists in the United States and Canada. It is the only national fund-raising organization for dental education and has the endorsement of the American Dental Association, the American Dental Trade Association, and the American Association of Dental Schools.

Money raised by the Fund is allocated to the dental schools to bolster faculty and help in expansion of the schools to ensure the training of more dentists to meet the needs of our expanding population, Dr. Hine said. The Fund also allocates a number of dental teaching fellowships, sponsors teaching seminars for dental educators, and provides grants for special programs undertaken by allied dental organizations.

Mr. Kerr's and Mr. Thornton's first duties as directors will be performed when they attend the midwinter meeting of the Fund Board in Chicago on February 7. This meeting will be held in conjunction with the annual midwinter meeting of the Chicago Dental Society, which will be attended by more than 8,000 dentists from the United States and many foreign countries.

Announcement of Regular Corps Examinations for Dental Officers, United States Public Health Service

A competitive examination for appointment of dental officers to the Regular Corps of the United States Public Health Service will be held in various places throughout the country on April 21, 22, 23, and 24, 1959.

Appointments provide opportunities for career service in clinical dental practice, dental public health, and dental research. They will be made in the ranks of assistant and senior assistant, equivalent to Navy ranks of lieutenant (j.g.) and lieutenant.

Entrance pay for an assistant dental surgeon with dependents is $6,017.00 per year; for senior assistant dental surgeon with dependents it is $7,470.00. Provisions are made for promotions at regular intervals.

Benefits other than promotion include periodic pay increases, 30 days' annual leave, sick leave, medical care, disability retirement pay, retirement pay which is three-fourths of annual basic pay at time of retirement, and other privileges.

Active duty as a Public Health Service officer fulfills the obligation of Selective Service.

Requirements for both ranks are United States citizenship, age of at least 21 years, and graduation from a recognized school of dentistry. For the rank of assistant dental surgeon, at least seven years of collegiate and professional training and appropriate experience are needed. For senior assistant dental surgeon, an additional three years, for a total of at least ten years of collegiate and professional training and appropriate experience, are required.

Entrance examinations will include an oral interview, a physical examination, written objective examinations in the professional field, and a practical examination in the various phases of dentistry.

Application forms may be obtained from the Surgeon General, Public Health Service (P), Washington 25, D. C. Completed application forms must be received by the Surgeon General *no later than March 6, 1959.*

First Annual Margolis Honorary Lecture and Meeting

The first annual Margolis Honorary Lecture and Meeting, sponsored by the alumni of Tufts University School of Dental Medicine, will be held June 12, 13, and 14, 1959, at the Hotel Statler-Hilton in Boston, Massachusetts.

The subject of the meeting (''Clinical Orthodontics'') will have as its theme ''Current Concepts Based Upon Past Experience and a 'Look' Into the Future.''

Participants will include Drs. Clifford Ballard, Allan G. Brodie, Carlos Coro, Herbert I. Margolis, Charles H. Tweed, Wendell L. Wylie, and other orthodontists.

There will be a program planned for the entertainment of the ladies.

Further details will be forthcoming in a later publication, and all pertinent information will be mailed to members of the American Association of Orthodontists.

Correction

In the list of Officers of Orthodontic Societies which appeared on page 79 of the January, 1959, issue of the JOURNAL, Dr. William D. Lee of Inglewood, California, was incorrectly listed as vice-president of the Pacific Coast Society of Orthodontists. Dr. Robert A. Lee, Times Building, Long Beach, California, is vice-president of the Pacific Coast Society.

Notes of Interest

Michael B. Di Leo, D.D.S., announces that his practice is now limited to orthodontics, 2 Country Club Dr., Flower Hill, Port Washington, New York.

Attilio F. Jannace, D.D.S., wishes to announce that his practice is now limited to orthodontics, 75-86 182nd St., Flushing, New York.

Robert J. Orr, D.D.S., M.S.D., and Milo M. Stucky, D.D.S., M.S.D., announce a partnership for the practice of orthodontics at 2850 6th Ave. and 4747 Mission Blvd., San Diego, California.

Dr. Russell S. Seidner wishes to announce the removal of his office from 1700 Main St., Niagara Falls, New York, to 817 Main St., Niagara Falls, New York, practice limited to orthodontics.

Dr. George T. Tunstall, Jr., announces the opening of his orthodontic practice at Presidential Gardens, Suite D-12, Tyler Bldg., Alexandria, Virginia.

Dr. Herbert Weiss announces the opening of his office at 490 Hialeah Dr. (Telephone Bldg.), Hialeah, Florida, practice limited to orthodontics.

OFFICERS OF ORTHODONTIC SOCIETIES

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American Association of Orthodontists
(Next meeting May 4-7, 1959, Detroit)

President, C. Edward Martinek - - - - - - - - - - - Fisher Bldg., Detroit, Mich.
President-Elect, George M. Anderson - - - - - - - 3700 N. Charles St., Baltimore, Md.
Vice-President, Ernest N. Bach - - - - - - - - - Professional Bldg., Toledo, Ohio
Secretary, Earl E. Shepard - - - - - - - - - - - - 8230 Forsyth, St. Louis, Mo.

Central Section of the American Association of Orthodontists
(Next meeting Sept. 28 and 29, 1959, Chicago)

President, John R. Thompson - - - - - - - - - 55 E. Washington St., Chicago, Ill.
Secretary-Treasurer, William F. Ford - - - - - - - 575 Lincoln Ave., Winnetka, Ill.
Director, Elmer F. Bay - - - - - - - - - - 216 Medical Arts Bldg., Omaha, Neb.

Great Lakes Society of Orthodontists

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Treasurer, D. C. Miller - - - - - - - - - - 40 South Third St., Columbus, Ohio
Director, Robert E. Wade - - - - - - - - - - - 327 E. State St., Columbus, Ohio

Middle Atlantic Society of Orthodontists
(Next meeting Oct. 4-6, 1959, Washington)

President, Stephen C. Hopkins, Sr. - - - - - 1746 K St., N. W., Washington, D. C.
Secretary-Treasurer, Charles S. Jonas - - - - - - Mayfair Apts., Atlantic City, N. J.
Director, B. Edwin Erikson - - - - 3726 Connecticut Ave., N. W., Washington, D. C.

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Director, Norman L. Hillyer - - - - - - - 230 Hilton Ave., Hempstead, L. I., N. Y.

Pacific Coast Society of Orthodontists

President, Richard Railsback - - - - - - - - - 1333 Grand Ave., Piedmont, Calif.
Secretary-Treasurer, Warren Kitchen - - - - - - 2037 Irving St., San Francisco, Calif.
Director, Richard Railsback - - - - - - - - - - 1333 Grand Ave., Piedmont, Calif.

Rocky Mountain Society of Orthodontists
(Next meeting Sept. 13-16, 1959, Aspen, Colo.)

President, Howard L. Wilson - - - - - - - - - 1107 Republic Bldg., Denver, Colo.
Secretary-Treasurer, E. H. Mullinax - - 209 Lakewood Medical Center, Lakewood, Colo.
Director, Ernest T. Klein - - - - - - - - - - 632 Republic Bldg., Denver, Colo.

Southern Society of Orthodontists
(Next meeting Oct. 11-14, 1959, Atlanta)

President, H. Harvey Payne - - - - - - - - - - 60 Fifth St., N.E., Atlanta, Ga.
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Director, Boyd W. Tarpley - - - - - - - 2118 Fourteenth Ave., S., Birmingham, Ala.

Southwestern Society of Orthodontists
(Next meeting Oct. 4-7, 1959, Houston)

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Secretary-Treasurer, Harold S. Born - - - - - - 908 S. Johnstone, Bartlesville, Okla.
Director, Nathan Gaston - - - - - - - - - - - - 701 Walnut St., Monroe, La.

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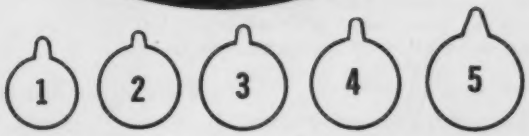

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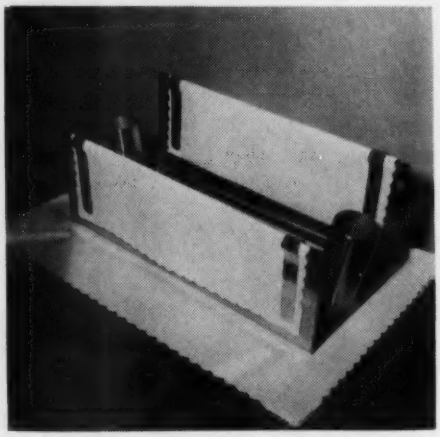

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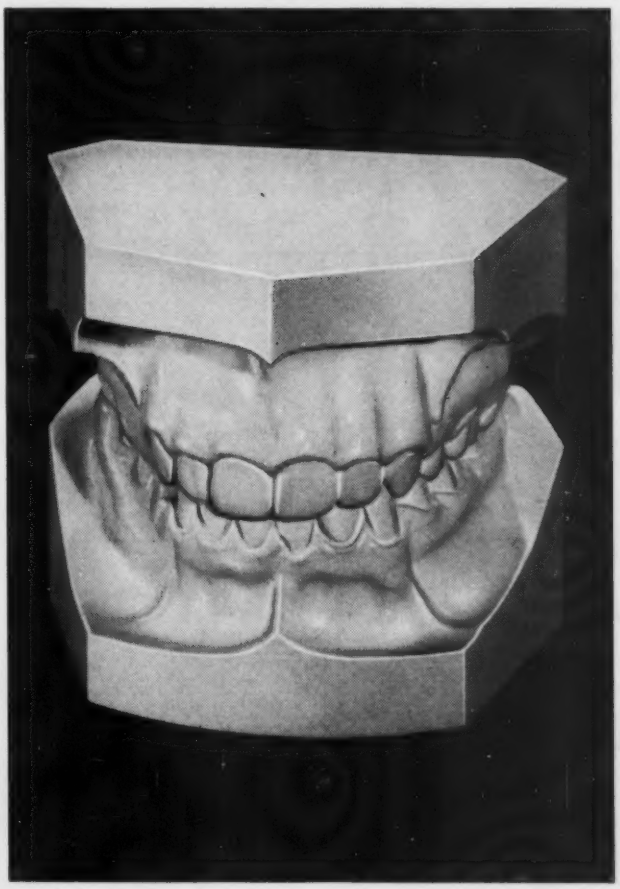

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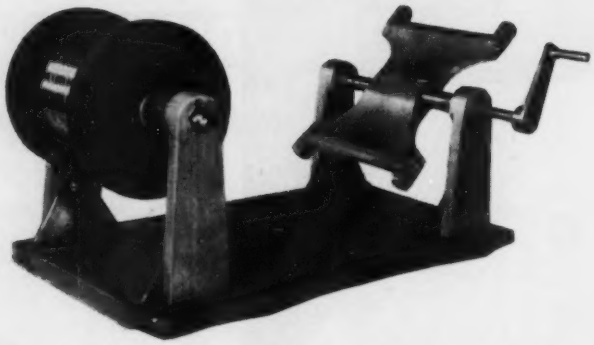

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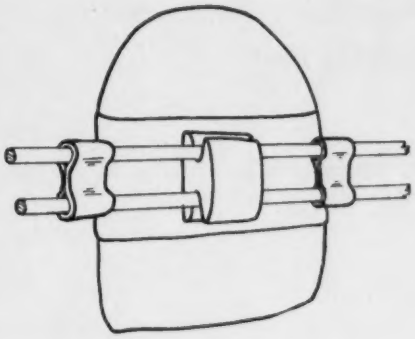

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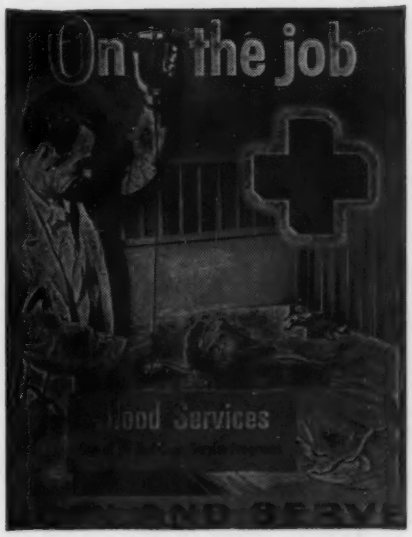

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Change of Address Notice.—Six weeks' notice is required to effect a change of address. Kindly give the exact name under which a subscription is entered, and the full form of both old and new addresses, including the post office zone number.

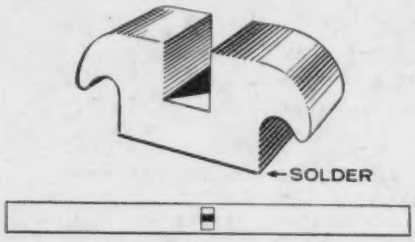
Advertisements.—Only articles of known scientific value will be given space. Forms close first of month preceding date of issue. Advertising rates and page sizes on application.

Bound Volumes.—Publishers' Authorized Bindery Service, 5811 West Division Street, Chicago 51, Illinois, will quote prices for binding complete volumes in permanent buckram.

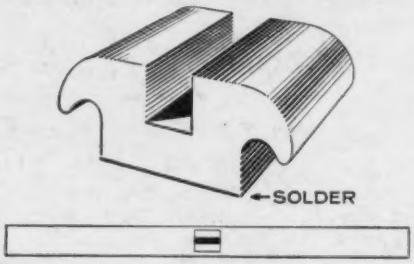
won't discolor in the mouth! can be used repeatedly!

S.S.White Edgewise Brackets

Anterior .050″ wide M 452S



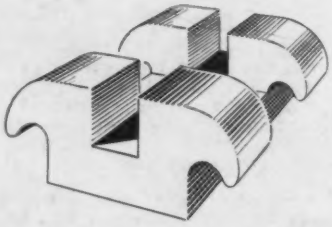
Posterior .100″ wide M 452AS



Pre-soldered Metalba* Edgewise Brackets are strong; remain clean in the mouth; can be soldered to; can be used on precious metal or Stainless Steel bands; and, used over and over again.

Divided Triple-width Edgewise Brackets

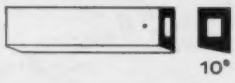
M 455



A convenient bracket for rotations as it provides two anchor points for ligatures. Supplied without solder to permit slight bending if required.

Anchor Tubes

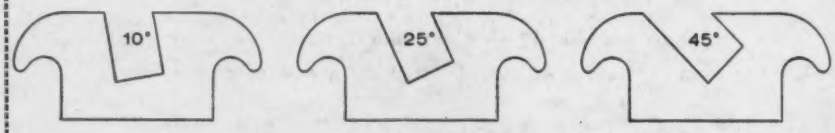
M 474



Metalba* Anchor Tubes for use in connection with Torque Slot Edgewise Brackets. They are ¼ inch long, rectangular tubes, with a bore of .022 x .028. The side of the tube which is to be soldered to the band has a 10 degree angle to permit it to fit into the Torque Slot Bracket assembly.

*METALBA—platinum color, precious metal.

Torque slot, Divided Triple-width Edgewise Brackets



The angle of the wire slot in the Bracket gives direction to the Torque force of arch wire.

M 516	Torque 10°	Width	.140 inches
M 517	Torque 10°	Width	.180 inches
M 518	Torque 25°	Width	.180 inches
M 519	Torque 45°	Width	.180 inches

METALBA

S.S.WHITE

THE S. S. WHITE DENTAL MANUFACTURING CO.

PHILADELPHIA 5, PA.